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SPACE WARFARE AND MILITARY STRATEGY

An Indian Perspective

BRIGADIER A K LAL

A UNITED SERVICE INSTITUTION OF INDIA PROJECT

PROF D S KOTHARI CHAIR

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"The vastness of space is a key factor in the war-form of the future"

—Alvin & Heidi Toffler

Future global rivalries would keep nations in an attritional posture in a wide range of fields...i.e. economical, technical knowledge, scientific breakthroughs and energy rivalries in a protracted infinite time scale. However, concept of wars would become outdated to be replaced by spontaneous short and decisive engagements. However, net wars (terrorist wars) may create a new dimension of warfare in the 21st century requiring combined space, air and specialist ground operations in a protracted time frame.

Therefore, smaller nations with smaller but Technological Doctrinal Oriented Armies would succeed in a smaller time frame against huge armies and huge land mass.

Desire in the beginning came upon that (the unevolved universe), (desire) was the first seed of mind. Sages seeking in their hearts with wisdom found out the bond of the existent in the non-existent.

—Rig Veda 1200-900 B.C.
(Translated by Arthur A. Macdonell)

"A Satellite vehicle with appropriate instrumentation can be expected to be one of the most potent scientific tools of the twentieth century. United States would inflame the imagination of mankind and would probably produce repercussions in the world comparable to the explosion of the atomic bomb..."

—Project RAND: Preliminary Design of an experimental world circling spaceship, May 1946.

"There are some who question the relevance of space activities in a developing nation. To us, there is no ambiguity of the purpose. We do not have the fantasy of competing with the economically advanced nations in the explorations of the Moon or the planets or manned space flight. But we are convinced that if we are to play a meaningful role nationally, and in the community of nations, we must be second to none in the application of advanced technologies to the real problems of man and society, which we find in our country."

—Vikram Sarabhai

At the dedication ceremony of the equatorial rocket launching station at Thumba on 2 February 1968.

FOREWORD

The 21st Century's first war has taken place in the form of America's war against terrorism in Afghanistan between the technologically oriented Americans and the medieval and obscurantist forces represented by the Taliban and Al-Qaida. It should put to rest any controversy on the relevance of space and space based weapons systems in any conflict of the present century. Revolution in military affairs has evolved due to the addition of 'Electromagnetic Spectrum' and 'Space', thus making it a five dimensional spectrum. Any military strategist and thinker cannot remain detached from such developments. Under these circumstances, it is heartening to endorse Brigadier AK Lal's pioneering efforts in space warfare and its relevance to military strategy. The book has lucidly covered the fundamentals of space warfare. Its applicability to Indian context has been well covered. Military strategy in the 21st Century requires total synergy between forces on land, sea and air, and the electromagnetic spectrum and space. Smaller nations with technologically oriented doctrines and concepts in their forces would succeed in a shorter time frame against huge armies and huge landmass. I am glad that the book has not only highlighted shortcomings in our vision as well as financial imbalances, but has suggested practical solutions. This should serve as a guide to defence analysts, financial planners as well as military strategists.

A well researched and useful product.

—Lt Gen Satish Nambiar
PVSM, AVSM, VrC (Retd)
Director, United Service Institution of India

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PREFACE

The subject, space and military strategy, is seminal and exploratory, at least from the military application point of view in India. At best one can draw a datum line from which the debate could commence. I confess, it is a very complex subject, which I have tried to simplify to the best of my ability. My approach, therefore, is fundamental in nature and I have tried to unfold certain principles of warfare after long hours of debate with various scientific and military communities. I have deliberately tried to be more ground centric being an infantryman. I have been given profound guidance by Lt Gen Satish Nambiar, PVSM, AVSM, VrC (Retd), Director, United Service Institution of India and Maj Gen YK Gera (Retd). I also wholeheartedly thank Professor Roddam Narasimhan, for all the interactions.

The basic hypothesis I have tried to develop is, that the world is currently experiencing what may be the most revolutionary period in all human existence with major revolutions taking place in geopolitics, science, technology and military affairs. Based on this premise, I would like to develop a 2020 scenario in which future wars would be divided in three distinct levels—prioritised as space, aerospace and surface forces (including the navy). Inter level synergisation by technology and supporting doctrines would be the cornerstone of combat capability and a nation's military potential, where the 'sensor to shooter' concept would prevail and the concept of paralysing enemy's Centre of Gravity rather than getting into a cost prohibitive attritional war.

In other words, in finality, **"Space would dominate and shape military strategy in the 21st century."** However, this

analogy may not completely stand true where there is an irregular or a net war situation like in the Indian sub-continent or what we see in the US attacks on Afghanistan. In this kind of scenario a different template would have to be applied as a counter-measure in which, again, partially space assets can help.

—A K Lal

ACRONYMS

AASW	Anti Anti-Satellite Weapons
ABM	Anti Ballistic Missile
AF	Air Force
AI	Artificial Intelligence
ALL	Airborne Laser Laboratory
AOA	Airborne Optical Adjunct
ASAT	Anti Satellite Systems
ASW	Anti Satellite Weapons
AWACS	Airborne Warning and Control System
BMD	Ballistic Missile Defence
CNS	Common Nuclear or Space
CTBT	Comprehensive Test Ban Treaty
CUSP	Cryogenic Upper Stage Project
DARPA	Defence Advanced Research Project Agency
DEW	Directed Energy Weapons
DoS	Department of Space
EEZ	Exclusive Economic Zone

EM	Electromagnetic
EW	Early Warning
FEL	Free Electron Laser
GBI	Ground Based Interceptors
GPALS	Global Protection Against Limited Strike
GPS	Global Positioning System
GSLV	Geosynchronous Satellite Launch Vehicle
HEO	High Earth Orbit
ICBM	Inter Continental Ballistic Missile
INSAT	Indian National Satellite
ISRO	Indian Space Research Organisation
IT	Information Technology
JLAS	Joint Land Air Space
KKWs	Kinetic Kill Weapons
KOR	Key Orbital Ring
LEO	Low Earth Orbit
LO	Liaison Officers
MAD	Mutual Assured Destruction
MARV	Manoeuvring Reentry Vehicle
MBTD	Minimum Battlefield Transparency Deterrence
MEO	Medium Earth Orbit
MET	Meteorology
MIRACL	Mid-Range Advance Chemical Laser

MIRVs	Multiple Independently Targetable Reentry Vehicles
MTCR	Missile Technology Control Regime
NASA	National Aeronautical and Space Agency
NATO	North Atlantic Treaty Organization
NBC	Nuclear, Biological and Chemical
NIE	National Intelligence Estimate
NMD	National Missile Defence
NORAD	North American Aerospace Defence Command
NSC	National Security Council
NTM	National Technical Means
NWS	Nuclear Weapons States
PENAIDS	Penetration Aids
PGM	Precision Guided Munitions
PLA	People's Liberation Army
PRC	People's Republic of China
PTBT	Partial Test Ban Treaty
RMA	Revolution in Military Affairs
SDI	Strategic Defence Initiative
SLBMS	Submarine Launched Ballistic Missiles
TERLS	Thumba Equatorial Rocket Launching Station
TMD	Theatre Missile Defence
TP	Thought Pulse
TRW	Thermal Radiation Weapon

UAV	Unmanned Aerial Vehicles
VSAT	Very Small Aperture Terminal
WARDEC	Wargaming Development Centre
WMD	Weapons of Mass Destruction

CONTENTS

Chapter–I

INTRODUCTION TO SPACE WARFARE AND MILITARY STRATEGY

"Earth space, like Eastern Europe in Mackinder's design, is most critical area of astropolitics. Control of earth space not only guarantees control of outer reaches of space but provides advantage on terrestrial battlefield."
—Everett C Dolman

Space has always captured the curiosity of man—from the early star gazers, who pondered the mere idea of flight to modern era engineers, who see star wars as an unfolding reality. Space and man's ability to use it have tweaked our imagination. Historically, early space exploration was simply buried in the pages of science fiction, or in the notepads of philosophers and inventors. It wasn't until the beginning of the 20th century that these fantasies and musings began to move up from drawing pads to the laboratory and eventually the skies. Jules Verne and Orson Wells helped shape our imagination, but the real development occurred through Dr Von Braun under the Nazi secrecy cloak prior to World War II.

The concept of space warfare is not alien to Indians also. For those who have heard the stories of great Indian epics *Ramayana* and *Mahabharata*, those who have had an interest in

Vedas and *Puranas*, the space warfare concept is as old as Indian mythology. When Lord Shri Rama decimated the army of demon king Ravana, on his way back, Lord Shri Rama, alongwith his victorious entourage, flew to Ayodhya in *Pushpaka Vimanam*. The vivid description of comforts of *Pushpaka Vimanam* as given in *Valmiki Ramayana* puts the best of the passenger aircraft of today to shame. When the battle between Lord Shri Rama and Ravana raged, both of them resorted to weapons like, *Agni-Astra, Varuna-Astra, Sarpa-Astra* which if one compares to today's arsenal, is nothing but missiles. The warriors of the yore even had *Sammohana-Astra*, a kind of Somnambulant, which can easily be compared to present day chemical weapon.[1]

There has been a complete shift from the times when warfare was limited to horizontal dimension only. In present day scenario, any victory in space would have a cascading effect on ground! Therefore, tomorrow's threat perceptions would become space centric too, which will change the balance of military power. Donald J Kutyana, earlier Chief of US Space Command says, "In a future of decreased, retrenched forces, we will rely on space even more, space systems will always be first on the scene." Even the Indian Chief of Air Staff, Air Chief Marshal AY Tipnis PVSM, AVSM, VM, ADC has reiterated the same on various occasions. It is precisely here, that space based military capabilities become an economical force multiplier in India's context, which has belligerent borders on the east, north and west, and the vast Indian ocean towards its south.

In fact, military strategists call space the new 'High Ground' which will bring in revolutionary changes in military affairs. Historically, new-in-principle technologies like the airplane, the tank or the atomic bomb have repeatedly upset the way war is conducted. Liddell Hart's tank theory and the German blitzkrieg rightly revolutionised armoured warfare. The atom bomb brought in the concept of 'Nuclear Deterrence'. Can we now start talking of 'Space Deterrence'?

The present and the future technologies promise a dramatic revision in the way security and military planners will think about

the conduct of future war. Central to this revolution is the idea that technology is about to overcome the most difficult problem in warfare – 'Finding the opponent'. Future hostilities can be visualised as a struggle for information domination, where information manoeuvre multiplies the effect of firepower and physical manoeuvre. Information and intelligence domination would then become the key to strategy and shape the philosophy and art of war.

In our context, we have always lacked behind in technology integration with strategy and doctrines. With the recently successful launch of the GSLV and PSLV, India's space prowess has got validated. The scientists have done their job. It is now for the military community to cause integration of our defence forces with space technology. As a first step, in the words of Dr V Siddhartha of the Defence Research and Development Organisation, "Gysmoisation and absorption of existing assets in the military systems is urgently necessary." Presently, therefore, militaries of developing countries have no choice but to evolve a new military paradigm in which combat superiority would be measured through technology and not only numbers. Space would provide the 'High Ground' in this technology era. It would give any nation a millennium opportunity to adopt the non-linear matrix for building military strength exponentially. We, therefore, have to realise and concretise the advantages that can accrue by a military strategy of space and ground convergence. Space ground linkages are best understood, in what Everett C Dolman[2] had to say: "Earth-space, like Eastern Europe in Mackinder's design, is most critical area of astropolitics. Control of earth-space not only guarantees control of outer reaches of space but provides advantage on terrestrial battlefield."

Warfare before the First World War was limited to the horizontal dimension only when invaders raided on horsebacks. But since after the first great war, vertical dimension is only adding infinitely i.e., even beyond space. Therefore, let us analyse if they affect warfare and their strategies. What impact do they have on nuclear strategy in a future milieu is definitely a moot question?

Can we achieve global security by preventing an arms race in space? To what extent space domination will give victory on ground? Will they make nuclear weapons redundant? Or can we have an integrated nuclear space strategy to offset conventional inferiority? Are conventional wars already outdated? Let us tackle all these questions one by one. First, let us see the historical perspective of space militarisation. Conventional wars are almost an outdated concept with the shrinking of the globe. Compare Alexander's long campaigns in 326 BC to the present. With modernisation and great technological advance, distances have shrunk. Warfare has been upgraded from bows and arrows and horses to Precision Guided Munitions (PGMs) and killer satellites. 2000 AD and beyond is bound to usher an era of space wars. As Frank Barnaby in his book *Future War* has said, "Today's military planners see space as a 'High Ground', a vital part of the military equation."

The current decade has seen a 'Revolution in Military Affairs' (RMA), which has been intense and phenomenal, particularly in the technologically advanced military forces including the exploitation in space. The same was articulated by Marshal NV Ogarkar (Russian Army) who gave RMA a technical colour and an important factor for future global security and planning. The forerunner in the RMA has definitely been Information Technology (IT), which is on the threshold of revolutionising human life and warfare too. It integrates all information in real time and thus its military application has no barriers, even when dealing with satellites and space warfare. Technologies related to space would occupy prime positions in times to come. Their application in space warfare is progressively enlarging since the 1957 Sputnik-1 launch by Russia. Reagan's proposed 'Star Wars' or Strategic Defence Initiative (SDI) although shelved as a whole, is proliferating in respective singular fields under different names like the Global Protection Against Limited Strike (GPALS) – type projects. Undoubtedly any victory in space would generate a cascading effect on ground. It is bound to outdo strategies of nuclear warfare alone, by an integrated

nuclear and space doctrine – or maybe by 'The space-sky-ground' doctrine. In the words of General Mormon of the USAF:

> *"An Integrated Air and Space Programme that combines total battlefield awareness and knowledge with rapid and dependable communications to get information to the decision maker or shooter fully integrated with highly capable, survivable aircraft and a fleet of unmanned aerial vehicles, both in the precision munitions, is the wave of the future."*

This concept proposes integration of technologies with weapon systems and their geographical locations like on earth, air and space; so as to churn a new theology impacting on the paradigm of future 'Force Structures', not so far in the distant future, maybe in the post 2010 period when star wars concepts may start being visible. Delineation of these structures for effective command and control would become the key factor in a proportional mix of forces, whose projections would be multi-dimensional with the combat potential being gauged by an interpolation of the respective military values of such services, i.e. the Army, Navy and the Air Force. Or do we require inducting a 'Space Force'? Conventionality of current military application would be surpassed by technologies in outer space. International bodies, which have raised a hue and cry on this account by treaties to curb this trend, have already proved non-starters. Therefore, tomorrow's threat perceptions would become space centric too, which will change the balance of global military power.

Until the Gulf War in 1991, the potentialities of 'Space War' never dawned. For their part, rated airman were quintessential operators with an ingrained fingertip feel for the practical uses of air power. General Mormon of the USAF has summarised the future trends in these words, "An integrated air and space programme that combines total battlefield awareness and knowledge with rapid and dependable communications to get information to the decision maker or shooter fully integrated with

highly capable, survivable aircraft and a fleet of unmanned aerial vehicles, both in the precision munitions, is the wave of the future." Thanks to this new focus, space has now been routinely integrated into joint training and exercise programmes of USA. It is vehemently agreed in the US that every joint force should have a permanent space-support cell. (Thus there is a requirement of synergising the total effort of space systems, to UAV and aircrafts, both fighter and strategic bombers armed with precision, through-the-weather, conventional bombs.) This is an innovative tactical option that a dedicated multi-command manual 3-1, for air and space might usefully codify in the US. Various combinations integrating AF and Space Army can be done i.e. by cross attachments or Liaison Officers (LO) etc. In the case of emerging countries other than America and Russia, which can launch satellites, there is a case to redesign and refashion their defence strategy, which should have 'Space-military technology' as an important ingredient. Thus, there is a case to analyse the future potential of space warfare and its impact on the military command and organisational paradigm and the new doctrine that the land, air and sea forces would apply for a more integrated and synthesised military operations even in areas of developing nations like South-Asia. Nevertheless, one cannot overlook the basic rift, which is widening between 'Space Power Nations' and 'Non-Space Power Nations'. The latter nations calling space the common heritage of mankind. Yet another emerging factor is the inter-Service rivalry.

The canvass of this subject requires a complete understanding of the astro-dynamics of space and the aerodynamics of the atmosphere. With this is required the analysis of breakthrough technologies and its impact on the defence services of modern states, so that its applicability in an Earth-Space environment can be crystallised. In this document the following issues will be highlighted—

- Fundamentals of space
- Evolution of space militarisation and emerging technologies

- Dialectics of military strategy
- Concept/Pattern of operations
- The need for a Common Nuclear and Space (CNS) doctrine
- The Indian experience: Glimpse at China, Pakistan and Indian capabilities
- Force restructuring
- Vision: 2020
- The Ballistic Missile Defence Debate
- Space Warfare: Implications, Legality and Debate

Chapter–II

FUNDAMENTALS OF SPACE

"In a future of decreased, retrenched forces, we will rely on space even more, space systems will always be first on the scene."

—Donald J Kutyana
Chief of the US Space Command

Historical Perspective

There are numerous references to space warfare in our own mythology. At the same time there is no dearth of atheists, so-called rationalists who sneer at these things and make fun of sacred texts. Agreed all these sacred epics always referred to them as *maya*, an illusion, but still we dare not say that it is the handiwork of a fertile mind. Instead of resorting to calling the rationalists infidels (albeit in a lighter vein), much credence should not be given to them. We must go on the premise that our ancestors had more to offer in terms of sophistication, with a quiver full of deadly arrows as arsenals, than what our westerners take pride in. Our ancestral heroes were not only exceptional terrestrial warriors but also sophisticated celestial warriors.[1]

Greek astronomers were the first to suppose that moving lights in the sky might be some other objects, but they still continues to believe the universe to be geocentric. However, an astronomer by the name of Aristarchus of Samos, argued for a heliocentric (sun centred) universe, as early as 280 BC.[2]

Up to the late 13th Century, the Church forbade, that there could be more than one world. However, when scientific inquiry raised doubts, the Church again condemned them. Nicholas Copernicus' work on the 'revolution of celestial orbits' (1543 AD) which postulated a 'Sun Centred' universe, was forbidden. Galileo's similar findings were also forbidden. Subsequently the ravels of science proved that even the sun was a small object in the cosmos, and was lying on the fringe and edge of a galaxy, which by itself was one of the billions of similar galaxies speeding away from one another into the depths of a universe with no finite end.[3]

From 1964 to 1968, US conducted thirteen unarmed Anti-Satellite Tests (ASAT), using Thor missiles based at Johnson Island, in the South Pacific. Their principle target would have been Soviet orbital bombs.[4] In the late 1960s, the first Soviet tests of a non-nuclear ASAT and testing of a 'fractional orbit bombardment system', marked the second round of weaponisation of space. The 1972 ABM treaty prohibits development and testing or deployment of space-based ABM systems. The same would be covered in details subsequently.

The earlier American space satellites showed that the earth is surrounded by high-energy particles – protons, electrons, hydrogen and helium. Nuclei, trapped in the earth's magnetosphere, starts about 600–1,000 kilometres above the earth's surface and collects particles of both cosmic and solar origin. Let us try to define space and its various levels.

FUNDAMENTALS OF SPACE

- *From an outer space vantage, earth's terrain is relatively smoother than billiard ball.*
- *What appears at first a featureless void is in fact a rich vista of gravitational mountains and valleys, oceans and rivers of resources and energy having peculiarities of astro-dynamics.*

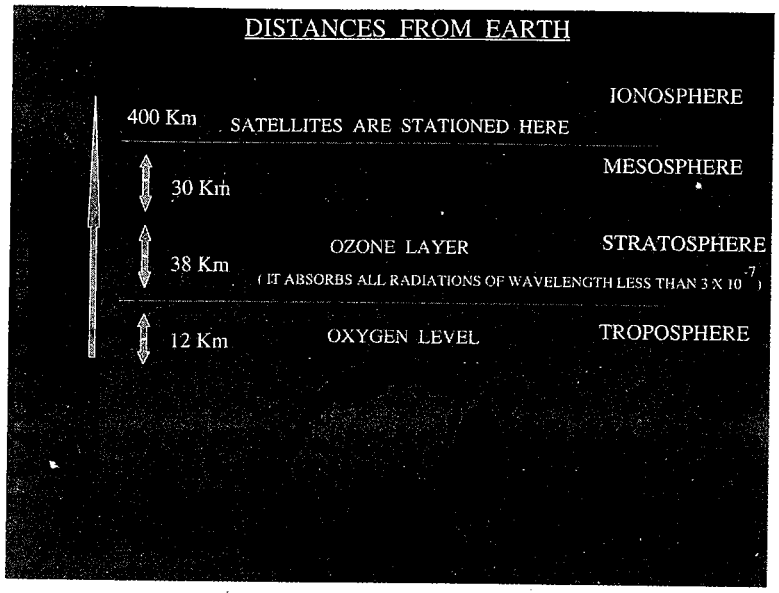

Figure 1

ABC of Space

Space is a term to denote the entire universe i.e. the earth and its atmosphere, the moon, the sun and the other solar systems over the infinite sky. 'Outer Space' denotes the entire space except the earth and its atmosphere. Outer space begins where the earth's atmosphere ends. The beginning of orbital space or circumterrestrial space extends from 60 miles above earth to about 50,000 miles. The space above can also be classified as Troposphere, Stratosphere (which also has the ozone layer), Mesosphere and the Ionosphere, where the satellites are normally placed. Inter se distances from the surface of earth are also shown diagrammatically in Figure 1.

Astronomy: Solar System

Before we embark on a study of the space wars, let us do a capsule on the astronomy of our solar system, especially of moon and the latest research details available. In our solar system we

have nine planets as given in chronological order from the sun with distance in kilometres—

- Mercury - (60 million)
- Venus - (100 million)
- Earth - (150 million)
- Mars - (229 million)
- Jupiter - (777 million)
- Saturn - (1426 million)
- Uranus - (2865 million)
- Neptune - (4490 million)
- Pluto - (5906 million)
- (Asteroid Belt) - (400 million)

As is seen, Earth is the third planet from the Sun and Mars is relatively closest to the Earth. In 1967, Mariners 6 and 7 passed Mars. In 1971, Mariner 9 went into orbit around Mars and thereafter in 1976, Vikings 1 and 2 landed on Martian surface. Although no life has been proved on Mars but there is a possibility of some water and organic compounds on Phobos and Deimus, the two satellites of Mars. Obviously, Mars has a space base potential. Similar probes are being carried out for other planets and their satellites. One cannot overrule that in the later part of the 21st Century, it may be used as space stations for a passing fleet. However, in the near future, the rivalry for the moon would result in military bases being established on the moon. As such the race to the moon has already begun. Let us understand the moon, a little more.

The moon is earth's satellite with a circumference of 10,920 kilometres as compared to earth's 40,077 kilometres. Earth has 81 times the weight of the moon. The distance from the centre of the moon to the centre of the earth is 484,404 kilometres, whereas the inter-surface distance is 476,366 kilometres. This implies that if the speed of travel towards moon is 1,000 kilometres per hour then the total travel time to the moon would be 19 days 20 hours and 9.6 seconds. Escape velocity from the moon is 2.4 kilometres per second compared to earth's 11.3 kilometres

per second. The moon's period of rotation is equal to the period of revolution about the earth i.e. 27.32 days. These astronomical specifications qualify the moon to be the base; the stepping-stone for future military activities in space at least till the middle of the next century. Countries would deploy strategic forces on it. Occupation of moon would be decisive at least in a global war.

Area analysis of space factually differentiates the largely unfamiliar medium from land, sea and air. Cosmic radiations, solar winds, micro meteorites, and negligible gravity (induces weightlessness) are unique properties of free space. Day-night cycles are non-existent. Space has no shape and little substance, affords limitless manoeuvring room. Sound or light cannot survive in the vacuum of space, distances are meaningful mainly in terms of time.

Space has no north, south, east or west direction. Right ascension is the astronomical analogue of longitude and declination, the astronomical analogue of latitude, is the angular distance north or south of the celestial equator designates location and direction.

The earth-moon system circumscribes four discrete regions: Earth and Atmosphere; Circumterrestrial Space; Moon and Environs; and Outer Envelope as shown in Figure 2.

Region III consisting moon and environment is of concern to us in order to elaborate on the military space. There are five lunar liberation points and three-dimensional positions in space in this region. Mathematical models and computer simulations indicate that free-floating objects within their respective spheres of influence tend to remain there, because gravitational fields of earth and moon are in balance. Spacecraft theoretically could linger for long periods without expending significant fuel.

L1 through L3, on a line with earth and moon, are considered unstable. Objects at those locations perturbed by the sun and other forces, will wander farther and farther away, if calculations are correct. L4 and L5, 60° ahead of and behind the moon in its orbit, assertedly are stable. Objects in those locations probably resist drift vigorously and, if it being, remain in that general region.

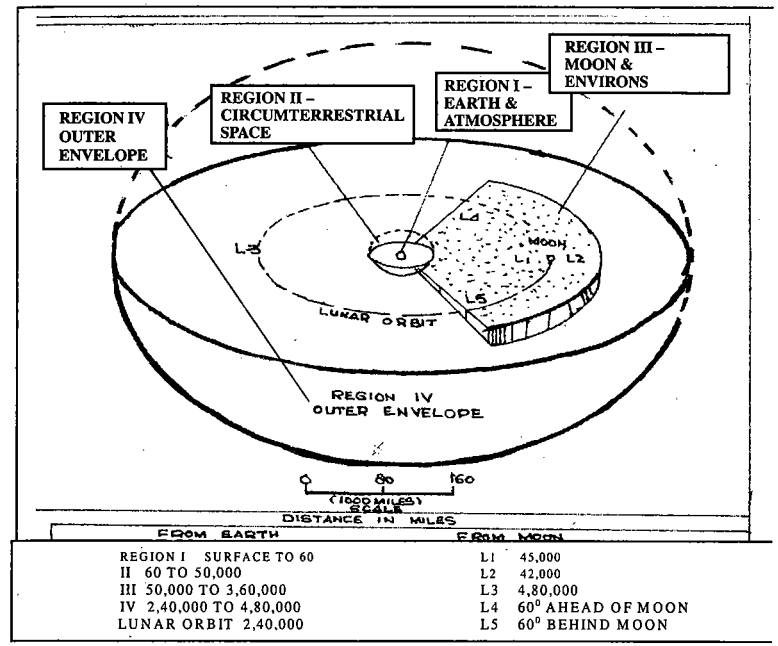

Figure 2

The validity of those hypotheses, however, has not yet been verified empirically. There are no observable counterparts of the Trojan asteroids that inhabit areas analogous to L4 and L5 along Jupiter's orbit. No probe from earth has ever confirmed or denied the presence of particle clouds that some scientists believe must be held captive. The size, shape and importance of each lunar liberation area thus remain subjects for speculation. L4 and L5, for example, may be larger or smaller than the 10,000-mile 'kidney beans' alleged; L1, L2 and L3 may encompass comparable areas, more or less.

Now let us look at probes beyond Mars. Voyager II, a project of NASA, has already toured outer planets and recently encountered a fourth, Neptune, about a year back. It would have travelled more than 7.2 billion kilometres when it reaches the eighth planet from the Sun. This project has discovered 19 new moons, till date. It is hoped that it gets into what is called the

interstellar medium. That is the gas which is between the stars.

Beyond doubt, the future lies in interstellar travels within and outside our solar systems. Voyager II proves this point. Probably in the first quarter of the next century Voyager type missions may be manned. To understand the vast expanse of military realms in space, understanding Plasma—the medium in space and the mechanics of orbital physics becomes necessary.

Plasma: The Fourth State of Matter

> *"The resulting mixture of free ions and free electrons known as plasma, has bewildered properties unfamiliar to those and earth, though it is the prevailing state of matter in the universe."*
>
> —JL Tuck, 1972

All matter surrounding our atmosphere at a distance of about 90 km from the surface of the earth and above is in plasma state. The maximum collection of charged particles in the universe is neither solid, nor liquid, nor gas, but it is in the form of plasma, the fourth state of matter. The solids, liquids and gases form only one per cent of the matter in the universe, the remaining ninety-nine per cent of the matter is in the plasma state, which has an equal number of positively and negatively charged particles. The atoms of any gaseous substance consist of a central nucleus. The electrons revolve around this nucleus, and get detached, due to extremely high temperatures of the sun. The atoms then become positively charged and are called ions. This ionized gas consists of an equal number of positively and negatively charged particles and that is plasma.

The visible light from the sun passes directly through the atmosphere, however the ultraviolet (UV) and X-rays from the sun interact strongly with the upper atmosphere air, producing ionosphere and ozone layers. With increasing altitude, the air becomes more and more ionized and above a height of 100 km, the ionized matter dominates the neutral form, and the region

from there on up to 1,500 km is called Ionosphere. Here the matter is in the plasma state, and reflects the radio waves in the broadcast band, allowing short wave communication on a worldwide scale.

There have been amazing advances in space technology and the development of the science of plasma. A very important plasma link between the sun and the earth has been found. The earth and the entire solar system is embedded in the solar plasma, called the Solar Wind.[5] Interaction of the solar wind plasma with the earth's magnetic field forms the basis for the understanding of our space environment. It also helps in breaking the myths of certain supernatural phenomenon occurring in the near earth environment. Study of plasma will assist us to achieve thermonuclear fusion, one of the potential sources of energy for the future.

In understanding the scope of military application it becomes imperative to understand the dynamics of radiation belts and the impact on orbital physics.

The Van Allen Radiation Belts[6]

> *"Instruments borne aloft by artificial satellites and lunar probes indicate that our planet is encircled by two zones of high-energy particles, against which space travellers will have to be shielded."*
>
> —JA Van Allen

James A Van Allen and other researchers reported on May 1, 1958 a new major phenomenon in geophysics, namely the permanent existence of two belts of high energy particles consisting electrons and protons. At the equator, these doughnut-shaped belts encircle the earth at distances of about 1.5 and 6 R_E from the planet's centre. An essential aspect is that these high-energy particles are found at low and moderate, but not at high latitudes. The belts do not extend above geomagnetic latitudes of about 75° S or N.

The radiation belts were discovered during the studies of cosmic rays with instruments aboard the first US satellite

Explorer I. The instruments included a Geiger counter for cosmic ray detection and a radio telemetry system for direct transmission of data to earth. The observation that a high level of radiation can jam the counter and reduce the counting rate to zero, led Van Allen and his colleagues to discover an enormously high level of radiation at altitudes of 650 to 1,000 km. When the satellite went out to these altitudes the counting rates dropped and ceased to count at all. This confirmed the existence of Van Allen belts. It started a new era in understanding of our space environment. Though the presence of such belts came as a surprise to the scientific community, however, their presence was, in a sense, anticipated. Way back in 1904, Carl Stormer, in Norway, had suggested that the geomagnetic field could act in this manner. Subsequently, many scientists considered the trapping of charged particles by the terrestrial magnetic field. In an experiment many scientists like Willard H Bennett allowed a stream of electrons to impinge on a sphere with a magnetic field resembling that of the earth. Some of the designed patterns obtained bore a striking similarity to that currently accepted for earth's radiation belt.

Today, with the plasma physicist's interest in confining plasmas by magnetic fields in order to produce thermonuclear reactions, we understand the plasma and magnetic field interactions quite well.

As has already been explained, the spiral motion and mirror points of charged particles in the earth's magnetic field cause the formation of the Van Allen radiation belts. Since, these charged particles move only along the geomagnetic field lines, the belt is effectively attached to and rotates with the earth. The Van Allen belt of electrically charged particles surrounding the earth does not reach lower than 650 km. This can be explained from the theory of reflection and loss of particles in the magnetic mirror system. Further, considering the drift of the charged particles around the globe, one can explain the doughnut-like shape of the trapped particle region.

Many experiments were carried out. The Explorer IV satellite (short ellipse) monitored radiation levels for nearly two months

at altitudes up to 1,300 miles. The Pioneer III lunar probe (long ellipse) provided data up to 65,000 miles. However, its orbit got distorted because of the earth's rotation during flight. This phenomenon, therefore, would impinge on space warfare. Without doubt, astro-scientists and military strategists should sponsor more studies on the subject.

The earth is shown below surrounded by trapped radiation belts. All spacecrafts have to avoid these belts and military manoeuvre would have to keep this factor in mind.

THE VAN ALLEN BELTS

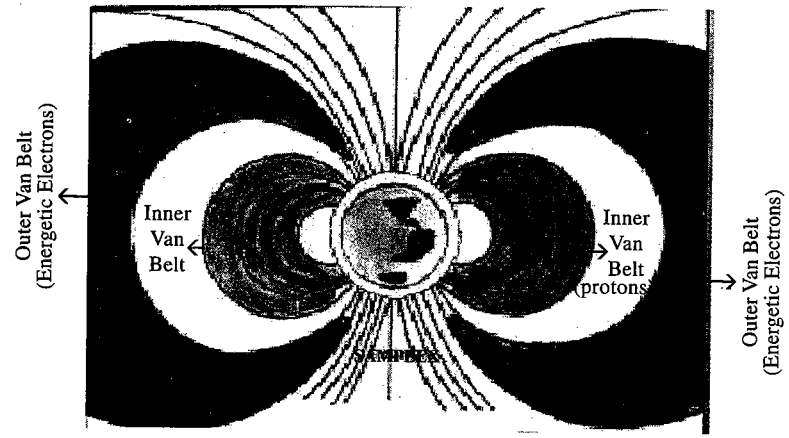

Figure 3

Figure 3 gives a schematic cross-section of the trapped radiation belts surrounding the earth. The Van Allen inner belt is composed mainly of energetic protons, while the outer belt is mainly energetic electrons. A newly identified radiation belt is composed of energetic heavy nuclei that originated in the local interstellar medium. All of those belts approach closest to the earth in the South Atlantic region because of the offset of the earth's magnetic dipole. The orbit of the polar-orbiting SAMPEX satellite, which has been studying the new belt, is indicated (after RA Mewaldt, AC Cummings and EC Stone, EOS, 1994).[7]

Earth's Magnetopause

The space around the earth is marked by the magnetic field of earth organizing itself as closed cavity called the magnetosphere, which is at a distance of about 10 R_E (R_E, radius of earth is 6400 km). The magnetosphere protects the earth from various harmful radiations from the sun and can thus be named the 'Lakshman Rekha' for the earth. The unique feature being that the magnetosphere environment radiates radio and micro wavelengths, but not in the optical range. Thus, these systems cannot be gauged by human eye but only by instruments, above the earth's ionosphere.

The radiation belts lie well within the Magnetopause.[8] The inner radiation zone is embedded in the plasma sphere and contains electrons with energies as high as several million electron volts (MeV). Typical energies in the outer belt, which lies beyond the plasma sphere, appear to play a dominant role in producing the 'boundary' between the two belts, unlike the electrons, the trapped high energy protons decrease in number more or less continuously with increasing distance from the earth. In the inner electron belt, the protons have energies of several hundred MeV, but on moving farther away the energies fall off steadily. During the active solar period the magnetic storms can cause large changes in the fluxes of the radiation belt particles. These would thus have to be factored during flight path military spacecrafts.

Anomalous Cosmic Rays and a New Radiation Belt

Besides the galactic cosmic rays and solar cosmic rays, instruments of the Pioneer X, IMP V, IMP VII spacecrafts discovered a third component of energetic charged particles known as Anomalous Cosmic Rays (ACR). It appears that these represent a sample of particles from the nearby interstellar space—the vast region between the stars. These cosmic rays originate in the process of complicated interaction between the interstellar medium and

the heliosphere, the magnetic boundary or magnetospheric boundary of the sun.

It has recently been shown that some of these ACRs have been trapped in the earth's magnetic field, where they form a new radiation belt composed of interstellar material.

In July 1992, the satellite SAMPEX was launched into a polar orbit carrying instruments designed to study ACRs in the earth's environment. During its first year, SAMPEX has confirmed that ACRs are singly charged particles and located in a narrow belt of trapped ACRs within the inner radiation zone of the Van Allen radiation belts shown above. The data from SAMPEX also shows that this belt is closer to the earth and is so narrow that the new radiation belt is analogous to a magnetic bottle that holds a sample of interstellar material. The SAMPEX observations have, therefore, provided an opportunity to examine the elemental and isotopic composition of a sample of interstellar matter, which, if we talk on a galactic scale, is located right in our own backyard.

Obviously, these Van Allen belts have to be avoided by spacecrafts. Any military strategy in space should consider these belts as minefields and bottlenecks. Understanding the orbital laws (including Hohmann Transfer Point) would help in avoiding these Van Allen belts. The basic orbital laws were established as early as 1609 by Johannes Kepler, and now known as Kepler's three orbital laws.[9]

Hohmann Transfer Point

To place a satellite in orbit it takes the launch vehicle to vertically accelerate in the initial phase. After this initial thrust, the trajectory curves over to adopt desired launch azimuth. The satellite and upper stage of launch vehicle together, finally achieve a horizontal path relative to earth. This is done by imparting an injection velocity to gain a circular orbit.

To place the satellite in high orbit, the velocity of satellite is increased in low earth orbit by means of thrust given by upper stage of launch vehicle. This results in satellite adopting an elliptical orbit, with its perigee at the injection point on low orbit.

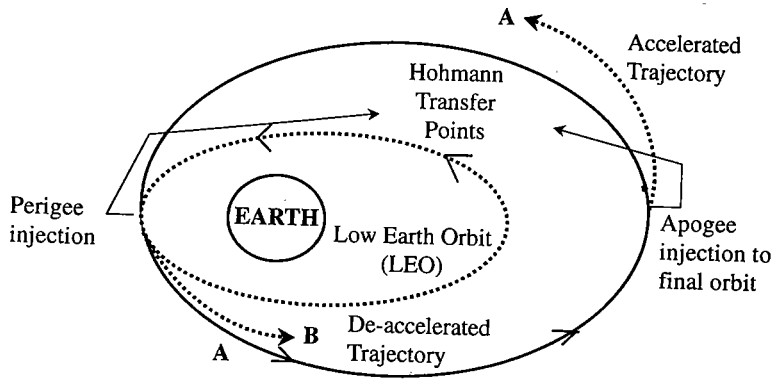

Figure 4: The Hohmann Transfer

This method is known as Hohmann minimum energy transfer from parking orbit (see Figure 4). The strategic importance of this point is phenomenal, owing to the fact that a parked satellite at this transfer point can be put into a new 'Astrostrategic' orbit with minimum thrust. See A and B for accelerated and deaccelerated trajectory respectively at the Hohmann transfer point. These points therefore become military strategic high grounds. It also becomes important to understand the astrodynamics of satellites with the help of Kepler's laws.

Kepler's Laws

There are three basic laws which have to be understood in comprehending the vectors of astrodynamics. Kepler's law is fundamentally related to the elliptical motion of the planets around the sun. A similar equation can be interpolated in tracing the path of satellites around the earth and is generally also true for circular orbits. (Basic concept is explained in detail in Brassey's 'Military Space' book, Volume 10. The theme and diagrams in the book have been utilised for amplifications as now being given.)

Kepler's First Law

• This law states that the orbit of a satellite around any planet is an ellipse. It further elaborates that one focus of the ellipse must be located at the centre of the planet, as depicted

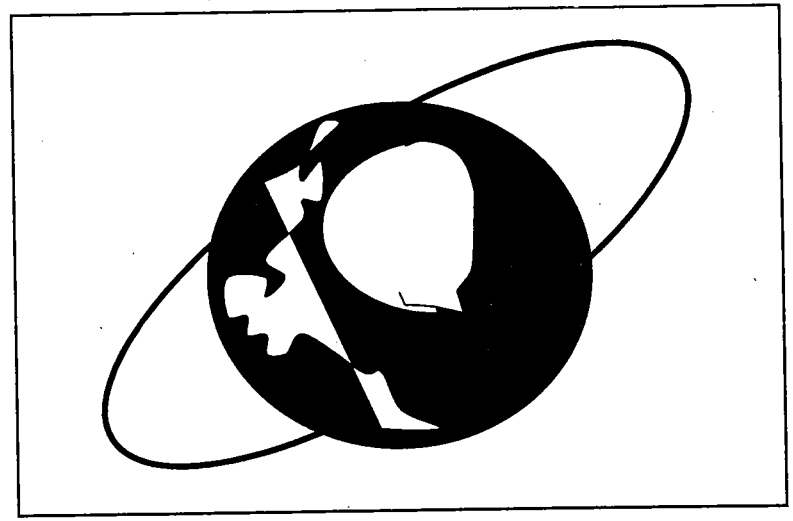

Figure 5

Source: Interpolated with ideas taken from Dutton et al, *Space & Orbital Physics*, London, Brassey's 1990.

in Figure 5.

• This basic law has a practical significance on launch sites, and the orbits achievable from those sites.

• The earth has an easterly spin, which imparts a useful velocity to the craft, when launched in the direction. Therefore a satellite launched from...say Cape Canaveral in Florida, in an easterly direction would follow the path as shown in dotted lines in Figure 6.

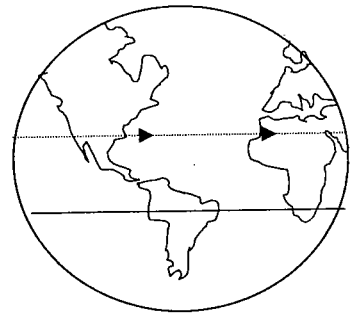

Figure 6: Launching Due East

Logically this dashed line should run around the earth at the same latitude from where it was launched. But this would result in the plane of this orbit not passing through the centre of the earth and would thus violate the basic physical first law of Kepler, of being away from the centre. Therefore, in actual fact, this elliptical orbit would have its centre in the equator or centre of the earth as shown in Figure 7.

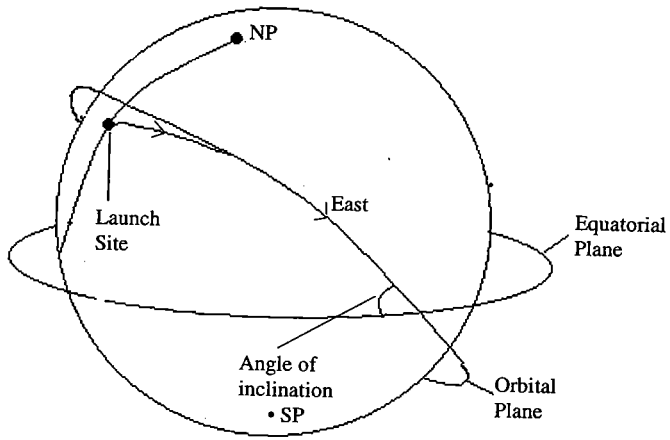

Figure 7: Plane of Orbit

As it can be seen, the plane of this orbit is inclined at an angle to the equator. This 'angle of inclination' is an important parameter of any orbit. This can be defined as the angle between the orbital plane and the equatorial plane of the earth's equator, measured anti-clockwise from equator to the orbital plane at the point where the satellite crosses, passing to the north. (Study of USA's Canaveral launch pad emphasises these laws:[10])

Interestingly, a study of launch through Russia reveals their comparative difficulty in launching as compared to USA. The Russians have two major launch sites, the most southerly of which is at Tyuratam, which has latitude of 46.5° North. The erstwhile Soviet Union therefore had more difficulty in launching into equatorial orbits than the United States, because the 46.5° plane

change requires more thrust and therefore more fuel, which resulted in larger design of vehicles, which again resulted in fuel penalty. The second major launch site of former Soviets is at Plesetsk which has a latitude of 63° North. Owing to its high latitude, this site is used to launch a satellite into highly inclined orbits, which requires larger vehicles and more fuel.

On the other hand India, owing to the location of its launch sites at 14° North latitude, the proximity of its launch sites to the equator, has an advantage over Russia, USA and even China. After the successful launch of its GSLV, technological prowess of own Space Research Organisation has been established. In due course of time, with the prospects of potential for commercial exploitation of own launch facility getting brighter, the cost of a satellite launch from India would be approximately half of the present day expense, being far cheaper than the other countries so mentioned.

Low inclination orbits which are desirable due to variety of reasons can be achieved by reducing the inclination after launch. A cost-effective solution is to build the launch site near the equator. French built their national launch site at Kourou, within five degrees of the equator, presently used by the European Space Agency to launch its Ariana series. Italians have built the San Marco launch platform within three degrees of the equator. The San Marco platform is small and to achieve an equatorial orbit, a small rocket launched from this site is effective enough. India's launch site, similarly gives natural pay-offs.

Undoubtedly, all the above orbital constraints, caused by launch site latitudes, are direct result of Kepler's first law.

In addition to the handicap caused by physical laws, there are some practical constraints to be considered. All launch agencies are faced with the problem of burnt out/used launcher stages falling back to earth. Most launches are designed for a fair amount of launch vehicle debris to fall back to earth. Obviously, this path must not be over populated areas. For example, the US has ensured that launches from Canaveral are restricted in inclination so that the debris always falls into the ocean. For more highly inclined

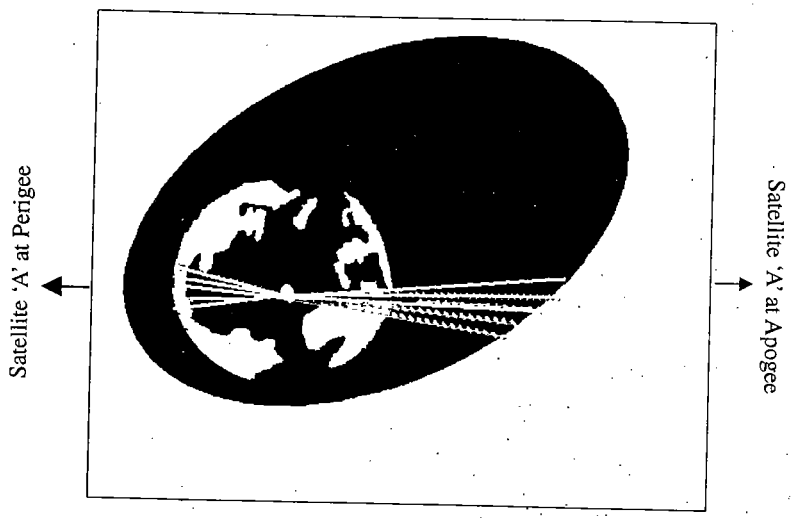

Figure 8: Kepler's Second Law (Sweep of Equal Area in Equal Time)

launches, Vandenberg Air Force Base in California is used. Russia's problem is similar but is slightly different. Ideally, they should launch due east at an inclination of 46.5°, but this would cause the rocket stages to fall into China. They are therefore forced to launch more to the north-east at the inclination of around 51° only. However, India again takes an advantage on this factor due to the proximity of the Indian Ocean.

Kepler's Second Law

Kepler's second law deals with the movement in the satellite on its orbit. An imaginary line joining the satellite to the centre of the planet scans and sweeps out equal areas in equal times. Figure 8 depicts two shaded portions of the orbit area which relate to equality in time periods. Undoubtedly, the satellite must be moving around the orbit at constant changing speeds for it to scan and sweep out an area at the same rate demanded by the law. An important characteristic is that satellite speed is maximum at perigee and minimum at apogee. Surveillance and reconnaissance satellites often have slightly elliptical orbits so

they can dip down low and fast over their target area. However, with more sophisticated satellites becoming operational and having lesser resolution, this technique may require revision, as the fast moving satellites have inherent problems in photography and surveillance akin to the problems of the fast moving jets. On the other hand, some communication satellites are launched into extremely elliptical orbits. As they head out to apogee, they appear almost stationary in orbit, making satellite tracking less of a problem in addition to being visible for quite long periods of time. (See Figure 8)

Kepler's Third Law

Kepler's third law deals with orbital time. This law dictates that the square of the orbital period is proportional to the cube of the semi major axis. In actuality this implies that the orbital period is dependent only on the length of the major axis; ellipticity has no effect. So if there were two orbits, one circular and one elliptical but with the same major axes, in so far as in the orbital periods these two orbital would be equal. Practically, the orbital period can be calculated if apogee and perigee heights are known. (See Figure 9)

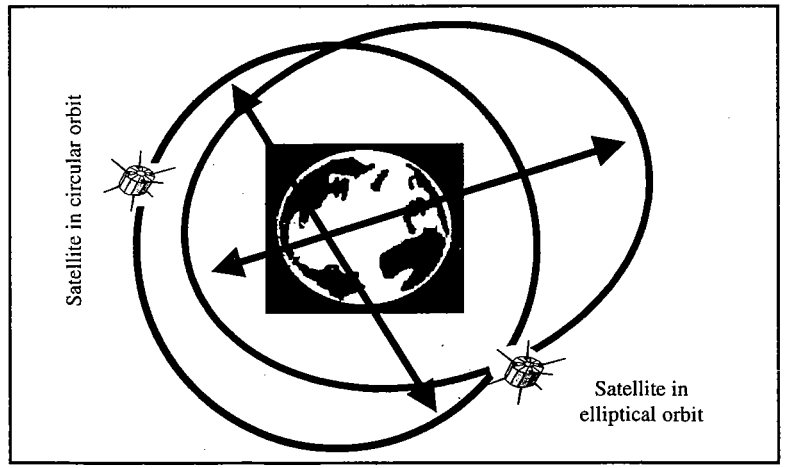

Figure 9: Kepler's Third Law

Practical Considerations

We have considered an ideal spherical earth, till now. Let us restore its natural properties and see what effects they have upon the laws considered so far.

Firstly, the earth is not a standard sphere. It more closely resembles a flattened sphere, or an oblate and flattened spheroid as it is more usually known. This flattening gives the earth a layer of extra mass around the equator, giving rise to two major perturbations and variation in satellite orbits.

Rotation of the Orbital Plane

The primary disturbance is the rotation of the orbital plane or also called nodal regression. This manifests itself as a rotation of the orbital plane about the earth's polar axis.

The direction of rotation is always reverse to which direction in which satellite travels. Thus, for a satellite orbiting in an easterly direction the orbital plane will rotate to the west, and vice versa. The rate of rotation of the orbital plane depends on orbital height and inclination. The cause of the effect is mass related, therefore, a low-flying satellite will be more effective than the one in a higher orbit. Further, a polar orbit suffers minimum rotation whereas equatorial orbits suffer from the maximum effect. For very low altitude equatorial orbits, the rate can be as high as around ten degree per day.

At times this variation can be a nuisance, but it can also be used to extremely good effect in what is known as an orbit which is 'Sun-synchronous'

Sun-synchronous Orbit

A surveillance satellite is periodically brought over the same area of interest for continuous monitoring. It would be very helpful in correct reading if it could be arranged for the same sun lighting conditions on daily basis. To achieve these conditions we need to have the sun always illuminating the orbit from the same angle. By launching into a low earth orbit inclined at about 98°, it is possible to use the orbital perturbation to rotate the orbit gradually

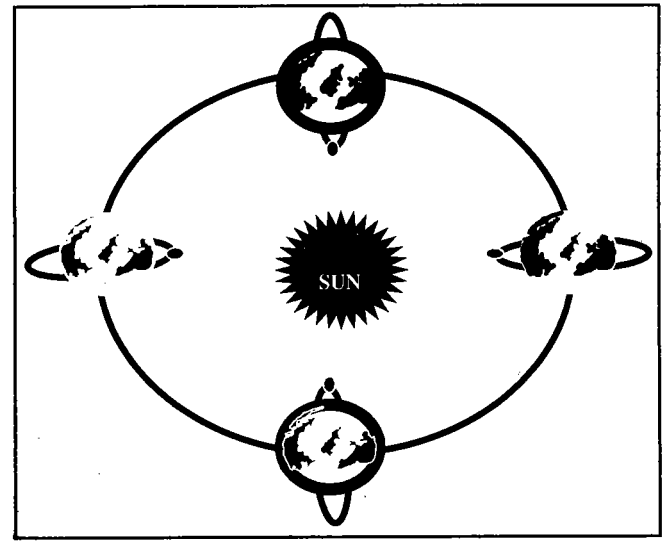

Figure 10: Sun-synchronous Orbit

from its desired fixed direction in space so that over the year we offset the effect of the earth's passage around the sun. This situation is depicted in Figure 10.

The Sun-synchronous orbit has been used for many years by optical surveillance satellites, meteorological satellites, whose images are frequently seen in the news media. The basic approach in such an orbit is to use the error in self-correction of orbit and maintaining the synchronicity with the sun thus facilitating commonality of the angle by the sun.

Major Axis and its Rotation

The earth's peculiar shape causes yet another type of orbital perturbation called the apsidal rotation, as the satellite moves between the apogee and perigee in turn. Further, the angle of inclination dictates the rotation rate of low and fast flying satellites. For a zero rotation rate, the inclination required is 63.4°. Therefore, if an elliptical orbit is needed whose apogee or perigee is fixed over any particular latitude, the inclination must be chosen as

63.4°. A good example of this choice are the highly elliptical Soviet Molniya communication satellites and even some of the Chinese satellites.

Residual Perturbations

There are many perturbations, which cause the satellite to change course. Other than the two major perturbations already covered, the earth's magnetic field, solar winds, micrometeoroid impact and varying gravitational effects, all cause minor variations in the orbital plane. To overcome such a problem, especially over a long period of time, rocket motors are fitted to correct the orbit time and again.

Effects of Earth's Rotation

Next, let us focus our attention on the earth's rotation to see how it influences the choice of orbit. The interrelation between the orbit and the rotating earth is quite difficult to perceive as it can't be described on paper. As explained in the book *Military Space*, first consider a circular orbit with zero degree of inclination. Clearly, the ground track of such an orbit is simply the line of the earth's equator. Next, consider a circular orbit with 30° of inclination and an orbital height chosen to give an orbital period of 120 minutes. Remember that the orbital plane remains fixed in direction in space while the earth rotates beneath it. As the satellite crosses the equator on the Greenwich Meridian, a stopwatch is started. Exactly 120 minutes later, the satellite completes the orbit and crosses the equator again. However, in this time, the earth rotated through 30° by virtue of its steady 15° per hour easterly rotation. So the satellite crosses the equator at its intersection with longitude 30° West. To the observer on the earth, who cannot sense the earth's spin, it appears that the second orbit is passing further to his west.

Considering an inclination of 60° and if these ground tracks build up over a period of time, successive orbits would fall further west under the influence of the earth's spin. However, the orbital period of 90 minutes divides exactly into a day, at the end of the

sixteenth orbit the satellite would again cross the equator on the Greenwich Meridian and the series of 16 ground tracks would be repeated *ad infinitum*. (In this simplified description, the earth's perturbative effects on the orbit are ignored.) Figure 11 shows the composite plot of the build up of the ground tracks. The plot clearly shows that the area of coverage by the satellite's sensors will be restricted to the area between 60° North and South of the equator. If the area of coverage is to be extended, the angle of inclination must be increased, to 90° or 120° etc.

If the angle of inclination is increased to 90°, the ground tracks build up again 16 tracks per day, repeated every day for a 90 minutes orbiter. At 90° inclination there is reasonably good coverage of most of the inhabited parts of the earth's land mass, but in military terms there are still some areas of strategic importance, particularly the arctic areas, which are outside the satellite's coverage.

A point worth noting is that although the plots represent one day's ground tracks, the coverage within the bounded area is not always complete. That would only be correct if the swath width (see Figure 12) of the sensor carried by the satellite was equal to the gap between successive ground tracks. At equator swath width is equal to approx 2,500 km.

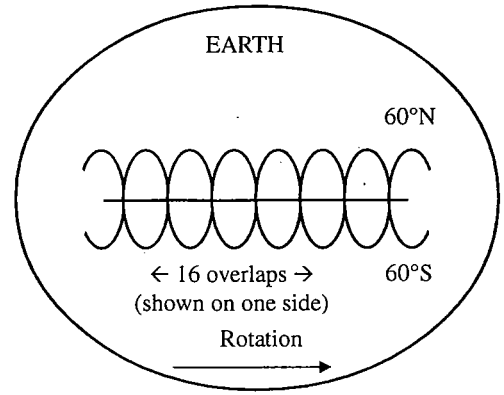

Figure 11: Ground Track for 60° Inclination

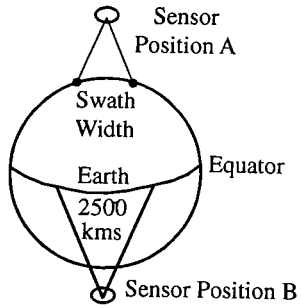

Figure 12: Swath Width

If full global coverage is needed ideally 90° inclination would be necessary, when the satellite would orbit between earth's poles and the whole surface would eventually be covered as it rotated beneath the satellite. But, again the time taken to achieve the full coverage would relate to ground track distance and the swath width of the sensor on the satellite.

BASIC ORBITAL PHYSICS

Let us summarise the basic orbital physics as shown in below—

- A satellite in orbit has its own uniqueness and eccentricity (defined as the ratio of half the distance between the foci of the ellipse and the semi-major axis).
- The perigee is the point where a satellite is nearest to the earth.
- The farthest point is the apogee of the orbit.
- A satellite usually takes an elliptical orbit, during the course of which the value of various orbit elements keeps on changing.
- Equatorial plane of the earth is inclined to the plane of the earth's orbit around the Sun. The line of intersection of these two planes is called line of the vernal equinox leading to the First Point of Aries.
- During the lifetime of a satellite, most of the orbit elements

are continuously changing, so that the values of all the elements must be given for a particular time.

- If a co-ordinate system is chosen such that its origin O is the centre of the earth and its z-axis is oriented towards the North pole and earth's equatorial plane contains the x-y plane, then it is possible to define the position of the orbital plane. The x-axis is oriented towards the vernal equinox of the First Point of Aries. The point (N) of intersection of the satellite ground track with the equator is known as the ascending node. The angle between the x-axis and the line ON defines the fourth orbital element called the right ascension of the ascending node.
- During the lifetime of a satellite, it does not remain fixed except for a particular value (90°) of the orbital inclination, the fifth orbital element. The orbital inclination perhaps the most important orbital element is the angle between the orbital plane of the satellite and the equatorial plane of the earth. It is the value of ω that determines the range of latitudes over which satellite travels during each revolution. Thus an orbital inclination of 90° facilitates complete coverage of the earth's surface for observation purposes. The orientation of the ellipse within the orbital plane is given by the sixth orbital element, known as the argument of perigee. Again ω varies continuously except for a particular value of the orbital inclination. If a satellite is launched at an orbital angle of 63.4°, its perigee will remain stable along any chosen latitude. For other values of the orbital inclination, it could vary up to 5° per day.

Chapter–III

SATELLITES IN SPACE: UTILISATION

- **RECONNAISSANCE (RECCE) SATELLITES**
  - **— PHOTOGRAPHIC RECCE SATELLITES**
  - **— ELECTRONIC RECCE SATELLITES**
  - **— OCEAN SURVEILLANCE AND OCEANOGRAPHIC SATELLITES**
  - **— COMMUNICATION SATELLITES**
  - **— NAVIGATION SATELLITES**
  - **— SCIENTIFIC RESEARCH AND METEOROLOGICAL SATELLITES**
  - **— GEODETIC SATELLITES**
- **ANTI-SATELLITE WEAPONS. (US-F15)**
- **ANTI-SATELLITE CAPABILITY (ASAT) [RUSSIAN PROXIMITY BLAST (ORBITAL ASAT)]**
- **SPACE-BASED DEFENSIVE SYSTEM**
- **ARMS CONTROL PARADOX**
- **SATELLITE USE IN DISARMAMENT AND ARMS CONTROL**

Reconnaissance Satellites

These satellites can be divided into four kinds – photographic, electronic, ocean surveillance and early warning satellites. They are used for arms control verification and for achieving battlefield transparency.

(a) Photographic Reconnaissance Satellites

Such satellites include television cameras, multi-spectral scanners and microwave radars, to detect pinpoint targets. The USA and Russia are the leaders in this area of space technology. The People's Republic of China has also launched many such satellites. KH-11, 9 and 12 are all versions of a photo satellite.

(b) Electronic Reconnaissance Satellites

These are the 'ears' in space. They carry equipment designed to detect and monitor radio signals generated by the potential adversary's military activities. These satellites also gather data on missile testing, new radars and many other types of communications traffic. Not only do they locate systems producing electronic signals but also measure the characteristics of the signals so as to be able to plan penetration of defences.

(c) Ocean Surveillance and Oceanographic Satellites

Knowledge of what is happening in the ocean – like the height of waves, the strength and direction of ocean currents, and salinity of the water – can help in the design of sensors to determine whether submarines are floating beneath the surface. These factors also contribute to improving the accuracies of missiles launched from submarines.

(d) Communication Satellites

Telecommunication was one of the first applications of space technology. Space-based sensors for surveillance of the earth, together with land-based surveillance systems, generate a considerable amount of data. The transmission of this and other data for military purposes needs reliable and secure communication systems. Space is an area of vital interest as some 80 per cent of military communications are carried out using artificial earth satellites. Satellites also play a vital role in the command and control functions for the military forces of the big powers. Even communications between mobile forces such as aircraft, naval ships and soldiers on foot and their commanders is being conducted

via satellites. These satellites are classified into three categories: geo-synchronous, semi-synchronous and orbital. Some of the satellites launched have been in 1960 – Echo launched by USA; 1964 – Intelsat; 1965 – Early Bird by USA, active geo-stationary; 1971 – Inter Sputnik by Russia; 1974 – Series of satellites launched by nations other than USA and erstwhile USSR.

On 10 December, 1982, the UN General Assembly adopted Resolution 37/92 pertaining to principles governing the use of artificial earth satellites for international direct television broadcasting.[1] An interesting point to note is that most US communications satellites are placed in geo-stationary orbit, while that time Soviets used a highly elliptical orbit.

(e) Navigation Satellites

Doppler analysis of signals emanating from radiating space-based radio beacons helps in navigation and global positioning. Even weapon trajectories can be monitored and countered suitably. Both the USA and Russia have developed satellite navigation systems. In the USA, an added mission is planned for satellites specifically to detect nuclear explosions in the atmosphere and in outer space. It is now planned that US navigation satellites will carry sensors for this purpose also. This effort is in support of nuclear war doctrines, which require early warning of attack, information and assessing the size of the attack and data on the attacked target so that an appropriate response can be made.

(f) Scientific Research and Meteorological Satellites

Other than the standard meteorological data, several new sciences have emerged like extra-atmospheric astronomy, space biology and space medicines.[2]

(g) Geodetic Satellites

It is a satellite, which studies the physical nature of the earth and thus assists in mapping the earth. Satellite laser ranging and radar altimetry have helped in ascertaining the pattern of earth's gravitational potential. This building of military

encroachment on outer space indicates that the military satellites of the major powers are increasingly becoming part of the worldwide nuclear and conventional weapon systems that threaten the planet's future.

> ***Nanosatellites.*** *'Nanosatellites' represent a revolutionary breakthrough in future satellite development. They are a type of distributed satellite structural system. Such distributed systems, in contrast to integrated systems, are able to avoid the damage that follows the malfunction of an individual satellite, and thus will increase the survivability and flexibility of future space systems. The best application of nanosatellites is their deployment in local satellite groups or in distributed constellations. For example, if we launch nanosatellites in solar stationary orbits, with 36 nanosatellites placed evenly into each of 18 equally spaced orbits, then there would be a total of 648 nanosatellites in orbit. Thus, we could ensure that at any given time, there would be continuous coverage and surveillance of any spot on the earth. Currently, there are already a few western countries that are researching 'microscale' satellites.*

Anti-Satellite Weapons

The 'conventional' weapons are based on missile and satellite technologies. Unconventional weapons are those which use directed electromagnetic radiation as a means of destroying or damaging a satellite.[3]

In USA, the Air Force, the Navy and the Defence Advanced Research Project Agency (DARPA) are investigating a number of potential devices for weapon applications. The US Air Force has carried out a number of tests using it's airborne laser laboratory (ALL) equipped with a 400 KW carbon dioxide gas dynamic laser. The laser radiation wavelength is 10.6 mm. In such a laser, the rapid expansion of the lasing gas provides the inverted

distribution of excited molecular energy states necessary for laser beam emission.

A laser beam can damage the target essentially in two ways. For energies between 10^6 and 10^4 W/cm^2 the incident continuous laser beam melts or evaporates the solid surface. At higher energies (considerably greater than 10^9 W/cm^2) and with shorter pulse lengths, not only does the target surface vaporize but it is also ionized, producing high-density plasma, which continues to absorb the incident laser radiation. The extreme temperature increase at the surface causes the laser-produced plasma to blow off or vaporize towards the laser beam. This, in turn, generates a hydrodynamic shock wave rupturing the target. In a chemical laser the inverted distribution of excited molecular energy states is obtained by means of chemical reactions. The most commonly used chemical reaction is between hydrogen and fluorine emitting radiation at a relatively short wavelength of 2.7 μ or deuterium and fluorine radiating at 3.8 μ. The Triad programme consists of three elements, code-named *Alpha*, under which the feasibility of generating infrared chemical high-energy lasers has been investigated; *LODE* (Large Optical Demonstration Experiment), under which a large mirror, 4 m in diameter, is being developed to steer and control the laser beam; and the space-borne *Talon Gold*, under which the target acquisition tracking and precision-pointing techniques have been investigated.[4]

Four more advanced laser concepts are also being investigated. These are the excited dimer and excimer laser, the free-electron laser, the gamma-ray laser or 'graser' and the X-ray laser. In the excimer laser (emitting radiation of 0.3 μ) electrons are used to bombard noble gases such as xenon or krypton so that the electrons in their shells are removed. The resulting ions while in excited state, react chemically to form xenon fluoride or krypton fluoride. They constitute the inverted population for lasing. It can be seen from Figure 5 that even at a laser energy of 200 kw considerable range can be obtained – of the order of 1,000 km. However, excimer lasers today suffer from low overall efficiencies (1–3 per cent) requiring multi-megawatt input power

for weapon application. Moreover, there are problems of severe corrosion and maintaining the purity of the lasing material, which make such lasers unsuitable as space-based ASAT weapons.[5]

Another different and untunable laser type is the Free-Electron Laser (FEL), in which electrons get accelerated to radiate. Thus, if a beam of electrons is focused through a magnetic field of suitably altering direction, the electrons can be made to emit coherent radiation. For short-wavelength radiation, the electrons must be highly relativistic. In principle, a wide range of frequencies may be available. Such a device could reach a high efficiency but needs a particle accelerator as an electron beam source.

The second concept pertains to Electro-Magnetic (EM) guns and could be regarded as a hybrid between conventional weapons and more futuristic directed-energy weapons. This is partly because the electric energy for an EM gun requires the same intense bursts as those needed for many types of directed-energy weapon. An EM gun simply hurls a projectile by using electro-magnetic forces rather than those produced by the expanding gases from chemical reaction. The main advantage is the momentum and higher projectile velocities. Thus an EM gun would be an important transitory step towards the possible realisation of Directed-Energy Weapons (DEW).

The third concept, the Electro-Magnetic Pulse Weapon (EMP), is based on the possibility of producing a directed EMP effect. Only a few nuclear weapons that explode in High Altitude Area in space could devastate the opponent's satellites and disrupt or even destroy electronic components of communications networks and computers. The EMP from a nuclear explosion 500-km above the earth, for example, would affect an area as large as the Asian continent. However, since the EMP weapon with directional property has not yet been devised, it would also affect the attacker's satellites. This problem is likely to be overcome in the future by a process of nuclear hardening of satellites. For example, production of an EMP effect has been studied using highly relativistic beams of electrons. These have been examined for their applications in laboratories to study the effects of EMP

on various components and electronic systems. Using an electron beam with energy of 400 MeV, a current of 250 kA and a pulse with 2 ns rise time, EMP effects have been simulated and their effects recorded. Thereafter, screening and Faraday effect is possible to protect key essential communication components. There is yet another irony that many of the ASAT weapons discussed above share the technology with some of the space-based defensive weapons, which continue as a very contentious issue as we transcend into the new millennium.

Anti-Satellite Capability (ASAT)

Weaponisation of space is already on, although the 'outer space treaty of 1967' prohibits the same. Most of the ASAT weapons tested up to 1980s fell short of the range in reaching military satellites.[6] Therefore, the present levels of ASAT held by both America and Russia would be definitely of longer range with the capability of destroying them. Both, nuclear and non-nuclear ASAT weapons, have been formed. According to an estimate, a total of 20 ASAT tests were carried out by the then Soviet Union between October 1968 and June 1982.[7]

Space-Based Defensive System

There are four concepts of a space-based BMD system. The first is that in which high-energy lasers are orbited. These are very similar to the high-energy laser weapons discussed above.

The second concept in this field is that proposed by the High Frontier Group. In this concept, 432 satellites, each armed with 40–45 missile interceptors, would be placed permanently in orbit round the earth.[8] The interceptors, each capable of obtaining a velocity of about 1 km/s relative to the carrier satellite, would be guided by infrared sensors to home in on enemy missile boosters and destroy them by colliding against them at high speed. However, this system by itself is very vulnerable. Thus, a third concept has taken roots.

The third BMD concept, which is partly space-based, is that which US presidential science adviser George A. Kayworth

also supported. This system would consist of several hundred lasers each operating at or near the visible light spectrum. The lasers would be interspersed throughout the US land mass and would be fired at large earth-orbiting mirrors launched in great numbers on warning of an attack by enemy missiles. The laser light would be reflected off and re-focused by these mirrors onto targets. This scheme is presently under trials; it is difficult to see how intricacy of launching and placing the mirrors in their correct orbital positions could be solved in time for enemy missiles to be intercepted by the reflected laser beam. The trajectory of an ICBM can be divided into three phases: the boost phase, during which time the ICBM is most vulnerable since it can be easily tracked by observations of the exhaust flame from the booster and the missile structure is under considerable mechanical strain; the mid-course phase, during which the missile releases its warhead or warheads; and the reentry phase, during which the warheads enter the atmosphere. The time taken by the ICBM during the boost phase above the atmosphere is less than five minutes. It is only during this short time that the beam could reliably intercept the ICBM. The total time for an ICBM to travel from one continent to the other is approximately 30 minutes. However, in a situation of theatre level missiles, the interception system would have to be yet better. The fourth BMD concept could operate in neutralising an ICBM during the reentry phase. The idea being to unbalance the heat shield to ensure burning off of the missile before it enters the earth's atmosphere. This can be even done by a non-Nuclear Area EMP explosion along a corridor dictated and identified by ballistics. BMD may yet take another intangible form by creating a 'Thought Pulse' (TP) in the corridor of entry into the earth's atmosphere. This TP can be created by breakthrough research through the medium of spiritualisation and capacitance to store the thought. Maybe, the world will get convinced over the domination of mind over matter. Presently, very little research has been done on this aspect, due to lack of human comprehension. (One private research group in India is doing same sort of work).

Paradox of Arms Control

Space based BMD systems have till today eluded America, Israel and many other countries doing research. It remains a paradox, as they may provide the umbrella against missile threats but concurrently dilute the deterrence value. This may then ultimately result in an arms race in the space. Therefore, actions to protect a missile strike may result in the dichotomy of proliferation of weapons in space. Thus, this will remain a paradox, unless the rogue states that are nurturing and mothering the legacy of irresponsibility and terrorism become accountable. One of the answers would be to stem terrorism globally and declare it as illegal and reprimand a state with punitive action under the aegis of the UN.

Militarisation and Weaponisation

Militarisation of space falls within the definition of utilising the services of satellites for enhancing performance of terrestrially based weapon, surveillance and communication systems. On the other hand, weaponisations would mean placing of weapon systems in space i.e., using space platforms. This issue will continue to be under hot debate internationally in the coming decade as deployment of Anti-Ballistic Missile (ABM) measures may find place in space. However, the present outer space treaty prohibits weaponisation. The military aspects of existing satellite functions would increasingly encompass the following as our dependence on satellites will increase four-fold—

(a) Command, Control, Communication, Computer, Intelligence and Information (C^4I^2). Space, air and land-based electronic and photographic equipment and sensors gather the array of surveillance and intelligence data. These are then passed in real time through various communication satellites, into a data fusion centre, integrated in a military command and decision-making system. Computer analyses and dissemination is done thereafter either by giving a command or a suggestion to a military centre or commander-in-charge of operations. In times to come C^4I^2 systems would

be completely in place and would also affect the nuclear deterrence capabilities. Integration of systems in the Kosovo crisis has come under lot of debate as it is believed that integration of the coalition forces fell much below the desired level, and would have to be streamlined before coalition warfare could be taken into the next century. The problems exist of joint deployment, communication, target identification, clear command channels and weapons compatibility, thus affecting interoperability. One of the major remedies would be the correct application of C^4I^2 systems for coherent synthesis. Space thus becomes the high ground of earth warfare. C^4I^2 cannot operate without space assets.

(b) Meteorology and Remote Sensing. The aspect of Meteorology (MET) in warfare is getting added importance, as any warfare where artillery, missiles, tactical nuclear weapons, chemical weapons or biological weapons are used, would be dependent on this factor. Remote sensing is closely interrelated with the 'MET' conditions as its efficacy is dependent on photography, cameras, multi-spectral scanner, infrared sensors and microwave radar. The Kosovo crisis in Europe and the Kargil misadventure by Pakistan in South-Asia have again re-emphasised the above point. Many NATO, remote sensing weapons and ammunition failed due to unfavourable MET conditions especially cloud formations. Most of the military satellites (about 40 per cent) in the period up to 1985 were photo reconnaissance satellites.[9]

(c) Early Warning and Electronic Intelligence (EW & ELINT). This is one of the key areas of satellite intelligence. ELINT can monitor all possible sources generating electro-magnetic spectrum and thus provide EW as well as information on enemy's capability including the performance data about the missiles and aircrafts. EW satellites carry infrared sensors to detect plumes of missiles so launched. The time of flight being 30 minutes, it gives adequate notice of an ICBM attack. Information from such satellites is

communicated to the North American Aerospace Defence Command (NORAD) space command at Colorado Springs and within 300 seconds of a missile launch, the NORAD is able to identify the nature of attack. This gives about 25 minutes to the defender to take recourse against the same.[10]

(d) Navigation Global Position. Satellites are in a position to provide real-time data of mobile ships, aircrafts or missiles which helps in targeting and navigation of the following—

- Mid-course navigation.
- Ascertaining very accurate disposition of troops and weapons.
- Positioning and ascertaining velocity of space vehicles and satellites.
- Assists movement of ground troops in areas where there are no navigational aids like in deserts (in the 1990 Gulf war, infantryman moved with the help of GPS).
- The US Navstar Global Positioning Systems (GPS) includes 18 satellites in 6 planes.[11] The current IRIDIUM project will have a constellation of satellites, which will connect the globe comprehensively.

Satellites: Utilisation in Disarmament, Arms Control

The SALT and ABM treaties have been monitored through satellites, which forms the primary National Technical Means (NTM).[12]

Counter-Measures to Space Weapons

- ASAT Weapons—Passive measures are many but they are not cost-effective, as hardening of satellites, placing them in higher orbit or having satellite manoeuvrable capability would dilute the basic capability.
- Counter-Measures to BMD Systems—The basic counter-measure would be to defeat the BMD system by a better technology and higher grade performance. It would also involve firing decoys to divert BMDs.

Chapter–IV

METAMORPHOSIS TO SPACE WARFARE

(Strategic Evolution and The Art of War: Thoughts of Ancient Vedic Times and Sun Tzu)

"Space would dominate and shape military strategy of the 21st century."

"Today's military planners see space as a high ground: a vital part of the military equation."

—Frank Barnaby in his book **Future War.**

Space and Levels of Military Strategy

The levels of military strategy in space could be delineated along following lines—

(a) Orbital military strategy which covers the space between the earth and the moon. This, as of today, is much beyond comprehension in the Indian scenario.

(b) Next possible strategy in the middle region is the aerospace level and has an impact on air and ground operations. It will affect military strategy of the future in the midterm time frame. It would thus include the higher atmospheric strata including hyper planes, conventional aircrafts and drones, helicopters and AWACS etc.

(c) The lowest level is the circumterrestrial or surface level

strategy. This is likely to have an impact on ground military strategy and would thus include Army and Naval forces.

Orbital Military Strategy

This is the first level and would imply the placing and operations of orbital satellites and would include the strata of HEO, MEO and LEO. The impact of any manoeuvre here would directly affect operations of adversary's aerospace force and the Air Force elements. Some other aspects are as enumerated below—

(a) The Geostationary belt is a strategic corridor and will soon become a geo-political conflict zone.

(b) The Hohmann Transfer orbit and the strategic narrow in a LEO become Vital Areas in space strategy.

(c) The significance of some of the Principles of War applicable for conventional war would reduce. Some additional Principles of War like Omnidirectionality and Synchrony would come into focus.

(d) The military manoeuvres would be dictated by concentration in time, centre of gravity and momentum/ operational tempo as regards rate of activity of operations.

Space and Nuclear Warfare tend to merge and become interdependent. In fact, tomorrow's nuclear war would slant towards flexible response by fourth generation systems. This perforce would require assistance from space. Space would become the 'eyes' and 'ears' of employing nuclear weapons pinpointedly with lesser collateral effects. Analytically, the nuclear war would ascend to the orbiting space platforms. Country 'A' without space capability cannot fight country 'B' which dominates the space. The space treaties to further ban weaponisation of space would be a non-starter and would become adjunct to NPT and the CTBT. Or do we foresee an S-5 group akin to the P-5 group, so emerging.

Yet another facet which would undergo a sea change is the definition of yet a higher form of strategy which may affect the outer space or the cosmos. The military definitions, which emerge

in a graded manner are—

- Minor tactics.
- Tactics.
- Strategy.
- Grand Strategy.
- Outer Space Strategy.
- Universal Strategy.
- Cosmic Strategy.

Minor Tactics and Tactics

These definitions are explained with live historical examples related to military warfare. This definition implies fragmentation of military action to achieve a tactical objective. The art of minor tactics involves field craft, guile, agility and momentum. The conglomeration of a series of successful minor tactics culminates in the achievement of a tactical objective. Similarly, in space, minor tactics would involve command missions by individual spaceman to raid a hostile spaceship with the help of 'space scooters'. In totality an offensive tactics of raid and space patrolling would give domination in a particular orbital plane. Therefore, domination of various orbital planes would become an important tactic.

Minimum Battlefield Transparency Deterrence (MBTD)

Yet another facet, which would undergo a change, are the forms of nuclear war fighting like minimum deterrence, which would get interlinked with MBTD.

Counter-Satellite Targeting

This would start drawing linkages with counter-force, quasi-strategic and counter-city targeting. An additional term of counter-cosmos targeting cannot be ruled out, although its application would depend more on an outer 'out of space' threat from some other planet or universe on the lines of the famous film *Aliens*.

Strategy and Grand Strategy

'War has its own language, but not its own logic to be the

single most important idea in all strategy.[1] Strategy is the summation of a successful number of tactical objectives and effect at the operational level. According to the traditional concept of military strategy, it should mean the art of employing military forces to achieve the ends set by political policy. Liddell Hart formulated this definition in 1929. The outcome of good strategy is almost felt immediately in achieving the military objective. In Kosovo, the strategy to execute 'Air Land Battle Doctrine' and soften the objective with precision guided munitions paid handsome dividends. It also served the grand strategy to expand eastwards and nudge into Russian interest. Kosovo was a grand strategy to prepare military machinery to operate 'Out of Region'. In space parlance, it would imply strategy to launch ABMs would be considered a part of the grand strategy of a missile shield in the first phase of a conflict followed by an offensive posture of firing lasers from space to ground and link up with rapid reaction, NBC capable mechanised forces so as to achieve victory on earth.

Outer Space – Universe – Cosmic Strategy

Terms akin to them would get evolved in the next millennium, as war planning would reach outwards, away from the planet earth – towards the moon and the sun. The region of outer space would reach half way to the moon or approximately at the zero gravity location notified by 'L', which will become a 'Key Orbital Ring (KOR)', the occupation of which would give a force multiplication in space weapon platforms. Therefore, outer space manipulation would become vital to the grand strategy on earth. Thereafter, sequentially, will come the 'Universal or the Lunar' segment, which has inherent advantages as explained later in the concept of operations. Therefore, in comparison, the word 'Universal Lunar' signifies the strategy in space. Going yet beyond, in the unknown will be the cosmic force, as per Hindu philosophy depicts the power centre of creation and may be the ultimate. Man may yet reach it as a part of his grand strategy to move beyond this universe, exploring new life into the infinite.

EVOLUTION OF WARFARE

Ancient vedic thought has spoken of space capabilities and even the analysis and resonance of the ancient military treatise of Sun Tzu leads us to newer principles of war for the 21st Century.

Warfare before the First World War was limited to the horizontal dimension only, when invaders raided on horsebacks. But after the First World War, vertical dimension is only adding infinitely i.e. even beyond space. Let us therefore contemplate on comparisons between ancient military strategies and transformation of contemporary and future military strategies. The task is to associate and extend existing geostrategic and politico-military principles and propositions to the described space model.

The capacity of the Armed Forces to produce a decision has varied fundamentally throughout history depending upon operational capabilities at the time and these in turn depended upon the armament, equipment, tactics and supply procedures of the opposing sides. One of the essential factors, therefore, in traditional military strategy has always been the capacity to grasp changes in the art of war more quickly than the enemy and so be in a position to foresee the effect, which new factors will have. India's Army as such has not been involved in the area of space at all. In the US and other European nations, the Army has been a customer/user of space systems. The time has arrived for the Army to be able to integrate the space systems into the overall scheme of war fighting. A historical analysis with the thoughts of the Vedic age, the *Mahabharata* and even of Sun Tzu are worth recapitulating.

In the modern Indian context, visions of space and interrelated anti-ballistic missile defence strategies and linkages have been articulated by K Santhanam.[2] Similarly Dr V Siddhartha[3] has been deliberating on the evolution of Space Warfare.

Strategic Evolution

One can retrace the strategic thought and space to the origins of astronomy. Sir Halford Mackinder keyed his classic study of world power to the classification of distinct zones on earth, whose interaction defined the course of global history. He had propounded the theory of Eurasian land mass as the world heartland[4] based on the revolution in transportation technology. Following Mackinder's lead, the resource potential of space like the heartland, is so vast and strategic that it would dominate terrestrial military strategies.

Greek astronomers were the first to suppose that moving lights in the sky might be some other objects, but they still continue to believe the universe to be geocentric. However, later, an astronomer by the name of Aristarchus of Samos argued for a heliocentric (sun centred) universe, as early as 280 B.C.[5] Up to the late thirteenth century, the church forbade, that there could be more than one world. However, when scientific inquiry raised doubts, the church again condemned them. Nicholas Copernicus' work on the 'revolution of celestial orbits (1543)' which postulated a 'Sun Centred' universe was forbidden. Galileo's similar findings were also forbidden. However, subsequently the ravels of science proved that even the sun was a small object in the cosmos, and was lying on the fringe and edge of a galaxy, which by itself was one of billions of similar galaxies speeding away from one another into the depths of a universe with no finite end.[6]

Coming to the last century both erstwhile USSR and USA have been advancing in space technology in leaps and bounds. From 1964 to 1968, US conducted thirteen unarmed Anti-Satellite Tests (ASAT) using Thor missiles based at Johnson Island, in the South Pacific. Their principle target would have been Soviet orbital bombs.[7] Russians have also been carrying out ASAT tests since 1950s.

Coming to the Indian epics and origins of thought, while referring to strategic evolution, *Yajurveda* talks of destroying the enemy at far distance before he contacts main defences. It says, 'Unassailable Agni, send forth the army to destroy our enemy,

be he far or near. Rise up, punish them all who fight against us, manifest your own divine strength. Blunt the weapons of the fiends, slay the enemy whether related to us or be he a stranger.'

This thought or adage gives kind of the new trends of warfare including space warfare.

A comparison of strategies of war followed in the distant and near past with those of the present and those likely to gain currency in the near future present us with a favourable insight into strategic evolution and the continuity of the Art of War. In this context, of course Sun Tzu, the Chinese strategist of the 5th Century BC, would also be a likely candidate. His thesis on the Art of War presents an interesting comparison with the strategic challenges and options available in today's world. It would present the reader possibly with an opportunity to extrapolate the route map of future strategic evolution. Clausewitz is not far behind. Even Chanakya's politico-military stratagems are applicable today. The basic tenets as propounded by all these strategists have common ground.

The strategic evolution of the Art of War through the ages has followed the emerging technological trends of the day. Indeed, the invention of wheel must have been as much of a decider of fortunes in wars of yore as have been the scientific and industrial revolutions in more recent centuries. Thus, in turn following and indeed at times leading technological evolution, strategic evolution bears a close interdependence with it.

The scientific revolution in the 17th Century followed by the industrial revolution with its ever-widening circles of influence shaped the world as we know it today. War and trade, riding piggyback on these advances were instrumental in the establishment of the modern world. The Europeans spread a continental political structure via their enterprising traders and well drilled and formidable Armed Forces which confronted and subdued societies with lesser developed stratagem. As the scope and scale of warfare increased and an impetus was provided to industries and scientific pursuits, a large scale demand for standardised industrial goods followed and the pattern for the

evolution of scientific and technological growth in the Western world was set. Thus, we witness that industrial enterprise and technological growth were stimulants to and in turn were stimulated by war needs. The technologies of production and destruction thus have been closely intertwined.

The Great Wars have followed the same patterns of strategic evolution. From trench warfare to armoured manoeuvre to air superiority the rapidly evolving tactics mirror the strategic evolution of the art of war as dictated by technological advances. In the present and the future too these trends are bound to continue and the evolution of warfare shall closely mirror technological and scientific advances.

For some time now the military mind, backed by technological and scientific evolution, has been looking to extend the one infinite element in the Trinity of land, sea and air to his advantage. The extension of the air dimension infinitely to spaces beyond conventionally thought of frontiers indeed marks a historical event in the history of warfare. In all likelihood it shall be documented by future military historians as the *Transparency Revolution* wherein locations of headquarters, logistic installations, troop movements, weapon trials, infrastructure etc. are indicated with pinpoint accuracy. Thus, the enemy shall have nowhere to hide from the High Ground in space. Anti Satellite weapons would not be far behind and have indeed been devoted thought for some time now.

It is of course a matter of debate whether a power that dominates space alone shall also dominate the earth but it is safe to assume that the one who has an advantage on the open flank of space shall exert considerable influence on earth. The support systems offered by space open a plethora of options for the Armed Forces on land and sea. Therefore, the extension of war into space is definitely a major step in the *strategic evolution of war*.

By the same reasoning it follows that as space gets crowded and various groups clearly start identifying the dominance of space as being crucial to their strategic interests, clashes over territories in space might well be the next development. But with

limited players as of now that stage may well be a few decades away.

Ancient Treatise: An Analysis

If one examines the ancient treatise[8] on the 'Art of War' one will come to a conclusion that the basic tenets only change interpretations and get modified in application. These are analysed below—

Weak and Strong Points. The Vedic writing, the *Mahabharata* and Krishna's higher directions of war all have shown exploitation of weak and strong points in warfare. Sun Tzu advocates an early occupation of the battleground with an aim of gaining tactical advantage and force one's will upon the enemy. Harassing the enemy to deny him rest and keeping him constantly on the move are recommended. He attaches the greatest importance to subtlety and secrecy of one's intentions and designs and the knowledge of those of the enemy. This he says will enable our forces to remain concentrated while dispersing those of the enemy since he would have to guard all his flanks equally. In this manner even a numerically superior enemy may be subdued. Concealment and camouflage are the instruments of achieving this. Tactics he says are like water, which takes the shape of the ground upon which it flows, thus emphasizing flexibility. He who can modify his tactics to always strike at the enemy's weak points is rated the best amongst commanders. Space warfare would allow this flexibility.

Manoeuvring. The best example of this kind of manoeuvring is during the Mahabharata war when Yudhishthir gave orders to Arjuna: "The enemy force is very large, our army being smaller, best tactics should be then deployment which will only weaken us. Array our forces, therefore, in needle formation. Mobilising and moving the troops as one harmonious entity, manoeuvring them to an advantageous position is rated as one of the most difficult aspects of successful war waging."

Sun Tzu cautions the commanders to consider both the advantages and dangers of adopting the indirect route to outmanoeuvre the enemy. He cautions against over stretching one's resources in this manner. An interesting aspect mentioned is mental manoeuvring whereby he stresses on deception, feints and dummies to confuse the enemy. He cautions against attacking an enemy uphill when he has the high ground, making a frontal attack on him when his back rests on the hills, attacking when his morale is high and swallowing a bait. He also advocates leaving an outlet free for a surrounded enemy so as not to press a desperate foe too hard. Space Warfare gives maximum scope for battlefield manoeuvre and satisfies the new evolving concept of a 'Dominating Manoeuvre' which basically is an integration of the electromagnetic spectrum, the precision guided munition fire power and the physical manoeuvre of Land and Air force at the identified centre of gravity of the opponent. Space facilitates the *Dominating Manoeuvre* and thus victory. Therefore, there is a requirement of evolving new doctrines of warfare.

Attack by fire. In *Vedas* the importance of fire[9] in the form of preliminary attack before the main attack is revealed in this manner:

> *"May you, O Agni, (Fire) grant us ample abode and comfort for our living and go in front of us attacking the enemy...May you subdue our foes on your triumphant march."*

In *Mahabharata*, Arjuna while destroying Duryodhana speaks about precision guided munitions (PGM). Sun Tzu said, "There are five ways of attacking by fire—to burn soldiers in their camps, to burn provisions, to burn equipment, to burn arsenals and finally to burn their lines of transportation." He also mentions the proper season for attacking by fire as being the very dry one. He, thereafter, deliberates on nuances of coupling physical attack with attack by fire and sets out five different case. A thought is also spared

for water and flooding as a means of overwhelming the enemy but he maintains that use of fire is superior. Direct Energy weapons fired from space may well bear this out. (In fact the new missile and artillery doctrines would all depend on precision capabilities, made possible only through space assets.)

Even *Vedas* say about fire in this form—

> *"O Agni, if your rapid flames ride the wind follow the fiends with all their blazing fury and flaming weapons. Let the demons be scorched with your tongues of flying flame, Agni let your fire brands rain all over the foe. Rise and sweep away those who take up arms against us. O Agni, burn down the enemy, you possessed of sharpened darts, humiliate and consume completely like dried up stubble, him, who creates mischief by encouraging our foe."*

Fire support is an important ingredient for a successful attack. In the yesteryears such a support could only be generated through ground artillery fire. However, with the metamorphosis of warfare to space, firing of lasers and guidance of precision munitions through satellites is now possible. This obviously would change and modify the cost and this principle of warfare, as amplified in the ancient text below:

> *"Arjuna smiled and replied: I understand. This man has come accoutered by Drona in charmed Armour. The Acharya has taught me the secret of this Armour, but this man wears it as a bullock might do. You will see some fun now! Saying this, Arjuna proceeded to shoot his arrows, first depriving Duryodhana of his horses, his charioteer and his chariot. Then, Arjuna broke his bow and disarmed him completely. Thereafter he sent needle like darts which pierced just those parts of Duryodhana's body that were not covered by Armour, until he could bear it no longer and turned and fled."*

The lesson learnt is that fire few and less but accurately on the target through PGMs. Space alone can make this possible.

Use of Spies. In *Arthashastra* Kautilya talks about spies and officers of secret service as early as 4th Century BC.

> *"The King...should divide the day as well as the night into eight part...During the fifth, he should hold consultations with council of ministers through correspondence and also keep himself informed of the secret reports brought by spies...During the first one eight part of night, he should meet the officer of secret service...During the seventh, he should hold consultations and send out the officers of the secret service for their operations."*

The last chapter is dedicated to the use of spies to gain foreknowledge. This he emphasises is the key to proper and timely utilisation of resources. For this purpose he classifies spies as—

- Local - The inhabitants of the area.
- Inward - Those in the employ of the enemy.
- Converted - Double spies.
- Doomed - Own spies who are deliberately made to carry false information to the enemy.
- Surviving - Those that return from enemy camp with information.

Spy operations are held to be essential in war and upon them the army is to rely to make its every move. Intelligence is thus accorded a high status even in Sun Tzu's scheme of things. The same is rendered possible through space intelligence and battlefield transparency created through space military assets.

Sun Tzu in his military treatise in 5th Century BC says:

> *"Therefore when victory is won, one's tactics are not repeated. One should always respond to*

> *circumstances in an infinite variety of ways."*

...and obviously space would be the best bet for multifarious response.

Sun Tzu deals with aspects of warfare under thirteen heads in which he covers comprehensively both psychological as well as physical and material aspects. Interpolation of these thoughts in modern and space warfare needs an analysis to come to some deductions.

Laying Plans. Under this first head Sun Tzu begins by reminding us that war is a matter of vital importance to the state, a matter of life or death, the road either to survival or to ruin. Hence, it is imperative that we study it thoroughly. He has spelt out five constant governing factors of war—

> *"There are five fundamental factors which are spelt out as the basics, which all Generals should be familiar with. They would of course be as relevant today with just a few modifications to cater for the complexities of modern war and space would be a major consideration under the second factor. Mastering these five factors says Sun Tzu will lead to victory and ignoring them to ruin."*

The Moral Law. This is interpreted by some commentators as politics and is explained as that which causes people to be in harmony with their ruler, to be willing to follow him. This would apply equally to any kind of warfare.

Heaven. We may interpret it as weather to signify cold and heat, the seasons and night and day. (The understanding and its relevance to space warfare is more applicable now.)

Earth. Militarily this aspect refers to terrain and the going thereof as well as how it lends itself to military exploitation.

The digitization of terrain and its space application has given precision strike capabilities in modern warfare.

The Commander. His virtues, talents and experience are listed under the fourth governing factor. But in today's scenario the commander has to be more a 'Techno-General'

Method and Discipline. The Doctrine, the Army adheres to, its operational procedures, the chain of command, the means of logistical sustenance and the ranks of its officers are considered under this governing factor. Obviously the aspect of space and its impact on military strategy would have to be rewritten.

Sun Tzu emphasises the importance of a speedy victory and does not favour protracted campaigns or sieges warning of the resulting unfavourable effects on morale and battle waging capacity of the state. He differentiates between haste and speedy operations and stresses that a protracted war has never benefited a country. Indeed twenty-five centuries have borne testimony to this fact. Space military capabilities obviously hastens the war.

The best policy in war, says Sun Tzu, is to capture a state intact, than to destroy it. So too an Army or any portion of it captured intact is designated better than one destroyed:

> *"To win one hundred victories in one hundred battles is not the acme of skill. To subdue the enemy without fighting is supreme excellence."*

Space precisely satisfies this adage. Space warfare should try to enable following policies—

- Attack the enemy's centre of gravity. (This could be enemy's electro-magnetic spectrum, an economic fulcrum or a strategic infrastructure.)
- Disrupt his alliances by diplomacy, and thus weaken him. Simply, it implies, isolating the opponent in the world force.
- Attack his physical military assets.

- Attack a strategic political town through military operations.

Actual fighting thus is accorded a low priority. The skilful leader is expected to subdue the enemy without fighting, capture his strategic and economic assets and finally overthrow his kingdom without lengthy operations in the field. To complete his triumph without losing a man is his preferred stratagem for offence. (The post 13 December 2001 stand off between India and Pakistan shows the contours of this stratagem.) Indeed space age warfare may see his idea of an ideal campaign come true in its entirety. The recent Kosovo or Afghan war was fought on this pattern. Space military assets allowed the American led alliance to attack Taliban strategy and attack them on their cities while they were holding fixed positions on ground. This led to many city's defences falling without a fight and mass surrender of the opponent (i.e. Taliban).

Sun Tzu has a sage word of advice for the sovereignty of the state. He warns him of the three ways in which he may bring misfortune upon his state:

- By ordering an advance or retreat when ignorant of their nuances.
- By interfering in administration of the military when ignorant of military affairs.
- By interfering with the direction of fighting when ignorant of command problems.

He sums up this chapter thus:

> *"Know the enemy and know yourself and in a hundred battles you will never be defeated."*
>
> *Space capabilities gives you complete battlefield transparency according to this adage.*

One may secure oneself against defeat but the opportunity of defeating the enemy shall be provided by him alone, says Sun

Tzu. He balances both offence and defence as requisites for a successful battle. Meticulous planning and preparations are held to be the cornerstone of a successful campaign. Discipline and the importance of following drills and procedures is stressed. He lays out the elements of art of war which in actuality is possible with the acquisition of space military capabilities—

- Measurements (of distances).
- Estimation (of quantity).
- Calculation (involving the above).
- Balancing of chances or comparisons.
- Victory.

(Each one of the above elements follows from a successful application of the preceding one. Thus victory is to be gained by careful calculations and considerations and not by fortuitous chance. Space military capabilities makes this possible.)

The management of forces, large and small, should be done with a scientific approach. He avers that whatever the size of the force, the basic elements of management remain the same, only a proper communication system needs to be in place.

Direct tactics, he says might be fine for joining battle but to secure victory indirect tactics are indispensable. These he compares to the five musical notes, which though finite are capable of generating infinite combinations. Thus, the combination of direct and indirect tactics applied in an endless circle are favoured. Timing is another aspect given importance as is the ability of a force to maintain discipline in all the chaos and tumult of the battle zone.

A skilled commander is supposed to be able to create circumstances, which shall force the enemy one way, or the other, thus exerting control over him without him realising it. He, thus, exploits a situation to his favour which again in today's scenario is possible relatively better by space domination.

Space and Contemporary Strategies

Contemporary strategists pondering the nuances of space

warfare would aver with most of the points made by Sun Tzu or as narrated in the *Vedas* or *Mahabharata*. If we return to the present day scenario with the infusion of the space dimension into our considerations, parallels could easily be drawn and the evolution of warfare would be put into perspective. Let us then consider the various challenges and options space warfare presents *vis á vis* time tested principles. Let us attempt to comprehend the strategic evolution necessitated by the induction of the space element in warfare keeping in mind the ends, the means and resources available, their optimal use and the countermeasures against them.

As in all strategic affairs, a clear sense of purpose at the highest level is essential to formulate credible strategies for space. National security interests must be clearly and coherently identified. Whether these interests are economic, political, social or scientific, they all have security implications. Two amongst these stand out as most likely causes of competition in space—

Economic Interests. The economic exploitation of space with all its vast untapped resources could well be the key to the dominance of a certain state in times to come.

Military Power. The earth is a tiny speck overarched on all sides by what we have come to call space. The military domination of space thus offers great tactical and strategic interests and is likely to be vital to national interests.

Furtherance of these is again governed by politico-military factors. To promote them without conflict would require political vision but might not always be possible. They have to keep sight of similar interests on earth and cannot be free of them. Dealing with aggression in the future might indeed be unachievable if support systems in space were not in place. What then would it take to have a fairly stable, secure international regime? John M Collins in his book *Military Space Forces—The Next Fifty Years* suggests three measures to achieve this—

Arms Control. Put into practice mutually acceptable

accords that leave all parties more secure thus reducing risks of war and deter forces of instability. These may not reverse or totally curb the militarisation of space but would aid in limiting it.

Terrain Control. The scope of terrain in this case extends to include all installations in free space. Their control would be vital to security interests and stability.

Attitude Control. "To subdue the enemy without fighting is the acme of skill," said Sun Tzu. Psychological operations shall continue to enjoy a high place in the scheme of things. Under this he suggests that the present space powers shall try to imprint upon the challengers' psyche the futility of efforts to achieve military superiority, perils to world peace and that the resources would be better utilised on raising living standards among other things.

Conventionally, thought of indicators of threat may be laid redundant in the changed scenario or would it not? Sun Tzu would be delighted to rewrite this treatise, as space is fertile territory for deception with its large uncharted and less understood facets. To gauge enemy capability both present and projected is a tricky proposition. The conventional methods of observation and inference are easy to confuse. Most civilian vehicles could easily be doubling as military instruments, indeed only token alterations would render them useful for military use. Weapons, lasers and sensors may offer no distinct features like those that distinguish a tank from a lorry. The most likely indicators would then be the pattern and number of launches, their time and place.

Modification of older theories may not be possible at all. New doctrines, concepts and theories could well be required to deter, defend and attack. The nature of threat themselves are difficult to predict and thus planners may have to rely extensively on assumptions. Certain factors that will have to be weighed, by space strategists are—

- Increase in the number of space faring blocs/nations.

- Interrelation between conflicts in space and on earth.
- Competition for lunar resources.
- Offensive operations from space.
- What shall constitute deterrence in space?
- Whether military superiority in space would imply decisive advantage?
- Impact of future technological breakthroughs in space.
- Availability of resources for development of military hardware in space.

Further, a potential conflict in space would require consideration of options for deterrence, offence and defence.

Transforming Deterrent Strategies

Presently the global security structure rests on the deterrence strategy. This is likely to get diluted with the interface with space capabilities like the present Anti-Ballistic Missile (ABM) debate.

Deterrent postures are aimed at alleviating the causes for attack. The two basic tenets of deterrence are non-provocation and preparedness. Non-provocation and preparedness may at times seem incompatible deterrent strategies. As preparedness itself may be viewed by a competitor especially a weaker one as provocation. A case in point is the cycle of action and reaction witnessed in the Indian subcontinent, wherein Pakistan has vied to match India's development step for step. Thus, what might have been preparedness for one was comprehended as provocation by the other. To develop deterrence is thus a challenge and the line between passive and active deterrence needs to be defined clearly and tread with caution. Appearances in this regard are indeed important and the right measures need to be carefully weighed. An action aimed at deterrence in space warfare which precipitates a pre-emptive strike would be a distinct possibility given the limited understanding of space warfare likely in the near future and thus the potential for overreaction.

Offensive operations in space are likely to mirror those on earth. To concentrate available resources on the right missions

as in the case of air warfare shall be important. Present day missions are of course limited to reconnaissance, and surveillance but as capabilities develop and hostile environments present themselves, mission priorities shall need to be carefully thought out. Likely targets could be—

- Space launch and control facilities on earth (and later possibly on the moon).
- Space based defence, offence and battle management assets.
- Naval Surface Ships.
- Ground forces.
- Installations of economic value.

The cost effectiveness of particular targets shall have to be the major factor in choosing targets. Precision strikes on high value targets will be the preferred option than saturation strikes over spread out defence installations.

Weapons shall need to be picked with great forethought. Non-lethal strategic weapons may already be an option; mass destruction weapons as well as precision ones shall be available in the future. The nature of the target, the resulting escalation and the damage to be inflicted are some of the factors to be considered. The likely categorisation of space weapons into 'Hard' and 'Soft' kill weapon by some analysts is useful. But what is more important is the cumulative and immediate precision strike enabled through space, that creates a phenomenon of 'Space Deterrence' or a transformed deterrent strategy in which the attacker, pre-empting an attack can be neutralised and damaged much more than he can initially inflict.

A prudent mix of active and passive defence would offer the best chance against an attack. The first line of defence in hi-tech warfare would be to elude detection by frustrating enemy reconnaissance effort. Concealment from radar, electronic, infrared and optical sensors would have to be catered for. Today a simple measure such as moving mobile targets out of range of observation of satellites passing overhead would still be effective. However,

as satellites start to cover more and more areas with reduced blind spots, this simple option would be redundant. For targets which are not earthbound eluding detection may be simpler, being a part of the vast space-scape. Absorbent coatings, heat shields, emission control, mobility and electronic countermeasures would have to be integrated to develop a feasible concealment plan. Dummies and decoys are still likely to be effective but attempts to entirely conceal locations might not be possible.

Active defence may entail interception, laying space minefields and booby traps and employing forward elements to delay, disorganise and canalise the attacking force along premeditated approaches much like in conventional warfare. The mission of any such elements will have to be clearly spelt out as in case of conventional warfare. Finally, reduction of damage should be given a thought as hi-tech space facilities are likely to be difficult to replace in an acceptable time frame. Such measures against soft kill weapons would be easier to adopt than against hard kill weapons.

All these would cause a shift in the existing deterrent strategies from 'Mutual Assured Destruction' to 'More Assured Destruction' (MAD) as defender's space capabilities would in any case mitigate a first strike, but will also enable a disabling strike thereafter. If American National Missile Defence (NMD) becomes operational, it will change the strike and 'MAD' matrix to asymmetric deterrence in favour of America.

Metamorphosis: Art of War

(Understanding the Net or Asymmetric Warfare)[10]

The metamorphosis of the Art of War from the earthbound *Vedic/Mahabharata*/Sun Tzu days to the space warfare of the future may seem dramatic but the essential tenets will hold. Sun Tzu's emphasis on deception, knowing the enemy, successful exploitation of the Earth and the Heaven and on fighting a moral war are likely to find an emphatic resonance in the space wars of the future.

The impact of this metamorphosis and the dialectics of the

evolving military strategy as already demonstrated time and again during the Gulf war, the Kosovo war or the present ongoing Afghan war, should convince us that there is ongoing shift in 'Art of Warfare'. All the above mentioned analysis indicates that the better concept for new warfare by weaker sides could be on the theme of a 'Net War' (Partially possible through using space assets). The modern example of such a Net War is the current terrorist campaign of Pakistan against India. However, they have not been fully able to exploit the concept of a Net War (as the *jehadis* are too rustic to be able to use technology and space) as explained further. Thereafter one would have to analyse the best and optimum countermeasures required to quell this Net War. Maybe, the answer would again lie in exploiting space military capabilities. A micro case study of this new phenomenon is necessary to bring home the point. Analysis will lead us to how new technology can assist formulation of Net War. (The basic research has been done by Rand Corporation, USA on Net War. However, the author has also done original research on the subject of 'Emerging Trends' in warfare. Concept and extracts has been discussed as relevant to space by the author.)

The term 'Net War' denotes an emerging mode of conflict at societal levels, involving measures, short of war, in which the protagonists use—indeed, depend on using—network forms of organisation, doctrine, strategy and communication. These protagonists generally consist of dispersed, often small groups who agree to communicate, coordinate, and act in an internetted manner, often without a precise central leadership or headquarters. Decision making in this context may be deliberately decentralized and dispersed. Thus, Net War differs from traditional modes of conflict and crime in which the protagonists prefer to use hierarchical organisation, doctrines, and strategies, as in past efforts to foster large, centralised mass movements along Leninist lines. Therefore, it is most suited to carry out a proxy war below a certain threshold and bleed the defending nation (the situation in Jammu and Kashmir is entirely akin).

NET WAR

Conflict and crime at societal levels that involves

- Measures short of war
- Protagonists who rely on network forms of organisation, doctrine, strategy, communications and technology attuned to information age.
- Protagonists likely to consist of dispersed small groups, but with state of the art communications.

Despite the modernity of the concept, history is replete with instances of Net War. The irregular warfare in North America during the French and Indian wars, and the American Revolution in the Eighteenth Century; the warfare waged by indigenous Spanish guerrillas against the Napoleonic occupation in the early Nineteenth Century, are some of the examples. In contrast to the currently emerging examples of Net War, the early cases were forced, largely by the circumstances, into Net War-like designs; these were not designs that were determined by explicit doctrine, or that could be sustained for long, or over great distances, due to lack of technology.

However, now, due to the Revolution in Military Affairs (RMA), one can inflict Net War proficiently to serve military strategy. The Osama Bin Laden (OBL) terror network had a Net War capability.

The RMA is providing modern armies with a qualitatively better Observation, Orientation, Decision and Action (OODA) capability. Obviously, the modern army with satellite surveillance and guidance is in a position to strike huge conventional armies. Imagine Rommel's Panzer divisions like in the North African campaign, all concentrated and lined up for a blitzkrieg. The modern army would reduce them to ashes within hours. Maybe the answer for the weaker side is to reorganise on the pattern of

smaller groups or in other words, evolve a 'Counter Netwarfare Doctrine (CND)', which neutralises moderate modernity to a certain extent. Let us amplify the thought process further. This phenomenon of Net War is nascent and in a state of infancy. It is still emerging, its organisational, doctrinal and other dimensions are yet to be fully defined and developed. The Net War concept comprises of a web of dispersed, interconnected 'nodes'. The nodes may be individuals, groups, formal or informal organisations, or parts of groups or organisations. The nodes may be large or small in size, tightly or loosely coupled, and inclusive or exclusive in membership. They may be segmentary or specialised. They may look quite alike and engage in similar activities. The boundaries of the network may be sharply defined or blurred in relation to the outside environment.

Net War Design Elements

- Web of dispersed, interconnected 'nodes'—
  - Nodes may be large or small in size,
  - Tightly or loosely coupled to each other,
  - Inclusive or exclusive in membership,
  - Specialised or segmentary.
- Flat structure: no central command, little hierarchy, much consultation, local initiative—a 'panarchy'.
- Central doctrine and decentralised tactics.
- Dense communication of functional information.
- A distinctive design with unique strengths (extracts from works of Rand Corporation).

The concept of 'Network-Centric Warfare' rests on an important doctrinal notion; victory in future battles will depend more on who has best 'Networks' than on who has the strongest

'platforms'. But so far writings about this, concept have focused mainly on technological level i.e. on the information and communication 'grids' that could enable the concept. The applicability of this concept at strategic level will be primarily to keep the opponent unbalanced. The capture of objectives and their subsequent consolidation will perforce have to be through conventional battles. The relevance, efficacy and validity of this newly emerging concept of war has been amply demonstrated in the recent conflict in Afghanistan. Had the OBL terrorists i.e. Taliban dispersed in the mountain rather than give consolidated battle in Kabul or Kandahar, the situation would have been different. The actual application of a Net War concept, would have then taken place, in which the Taliban alliance would have struck at will in the form of terrorist attacks. Therefore, 'Counter Net-war Strategy' (CNS) in turn has to be based on more sophisticated technology and knowledge application, which could be real time or protracted.* Any state which wants to win the Net War will have to apply 'CNS' accordingly. Space, if harnessed, would become the node of such a 'CNS'. This obviously would have to be combined with conventional military capability in tandem.

The ongoing space revolution is also changing the military principles of war. Some of the earlier principles would have to be modified. Some additional principles would have to be adhered to.

Space Warfare and Transforming Principles of War

In the present scenario, because the Taliban/OBL group tried to hold objective and did not apply the Net War philosophy correctly, thus they have actually collapsed. The Net War can be countered by improving ground troops satellite connectivity, the emphasis should be to shift ground based intelligence to space based system towards the mission specific satellite. Nevertheless,

* More details of same mentioned by author in his latest book on 'Terrorism' which however is not being covered here.

again it is space alone the domination of which can counter a Net War concept due to the real time information management followed by precision response which can even destroy smaller groups hiding alone even in caves. Therefore, in totality, there is a need to understand the metamorphosis which is taking place in warfare, mainly due to space being militarised, which in fact is also affecting the traditional principles of war.

To adequately satisfy the requirements of operational and tactical commanders, future space systems must be tailored, available, dedicated and operated to support the 'Air Land Battle Mission'. Measurements of land power must take into account all of the geographic features, installations and technologies (weapons, sensors and their support systems) which enable a nation to use force on land. Any technology which plays a role in this exercise of land power, land-based or not, is an instrument of land power and, when incorporated into the commander's force structure, may have a far-reaching effect on land force operating capabilities.

Satellites provide the means for enhancing command and control, facilitating the manoeuvre of forces, reducing the commander's uncertainty, and improving fire support, air defence, intelligence collection, and combat service support operations. Further, development and optimum integration of space operations into land operations will enhance the success of future Army missions. The full range of beneficial space operations must be available to commanders to capitalize on all combat assets. In light of this it becomes essential to review the basic principles of war that will get modified with the use of the new high ground-space.

• ***Selection and Maintenance of Aim.*** The aim of each campaign/battle/operation has to be compatible to the resources placed at the disposal of the commander. With the resources of space being available the formulation of aim is likely to be affected specially at the theatre level. Actually the aim will be enhanced and encompass larger space and scope. Usually the enemy may deliberately launch subsidiary operations to divert the commander's

attention and resources from the selected aim. Space warfare will ensure suppression of enemy efforts to the extent of degrading/ neutralising his capabilities and ensuring that the commander is able to maintain the selected aim. The ultimate aim of war being the destruction of the enemy's will to fight will be better achieved by the use of space power.

• ***Maintenance of Morale.*** The type of battlefield supremacy achieved by space weapons in itself is a moral ascendancy over the enemy and will per se increase the morale of the troops, the nation and degrade the enemy's will accordingly.

• ***Offensive Action.*** Offensive action flows out of the relentless pressure on the enemy by application of all available firepower and forces in a co-ordinated manner. In fact opportunities are required to be created to inflict losses on him. Commanders will be now able to create such opportunities easily by applying space based fire support after acquiring real time information of enemy's deployment and military installations again by satellite based surveillance means. Space warfare shall, therefore, be able to greatly enhance the commander's capability to improve this very important principle of war.

• ***Surprise.*** Surprise means to be able to catch the enemy off balance and force him to give battle in circumstances unfavourable to him. Surprise also implies that commanders are able to guard against enemy's capability to surprise him. Space based support of surveillance and fire can be very powerful influence in achieving the desired results. Surprise by itself can be achieved by new techniques, material and equipment that are again possible by application of space power. Satellites in orbit are forward deployed, mission ready and responsive to user requirements around the world. Space assets can be used to acquire and distribute timely information that reduces the level of uncertainty about a given situation or condition. During combat, this would include information about an adversary's readiness,

force location and posture, direction of movement, and terrain/ battlefield visualisation, thereby facilitating power projection and knowledgeable entry into a theatre.

• ***Concentration of Force.*** The use of space-based forces has the advantage of being deployed without revealing interest or intent. This principle traditionally implies physical application of forces at the decisive time and place; quick concentration for fighting and dispersal when not fighting, assume greater importance. This would prove disastrous in a space dominant scenario, as any concentration on ground, is likely to invite strikes from 'Direct firing laser satellites'. Conversely, for the attacker, the space-based weapons can be applied at any place and time without any need for physical movement. This ensures concentration of firepower for the ground forces as well as surprise. Near real-time communications and intelligence, precise positioning and location information and environmental monitoring translate directly into increased weapon system performance and lethality for ground forces. The ability of the commander to effectively command and control forces, and to see the battlefield, regardless of size or maturity, permits ground forces to react faster than the enemy. The development of a force application capability from space will extend the power projection capability of the force against surface targets. This capability will support deterrence and will permit the attack of high value targets throughout the area of operations. Additionally, it will assist in protecting land forces from attack by strategic and tactical aircraft and missiles and facilitate manoeuvre.

• ***Security.*** Security, as a principle of war, is giving freedom of action to a commander to enable him to seize opportunities to inflict losses on the enemy by bold action. Space-based weapons and satellites amply facilitate this as discussed before. Security also calls for adequate measures to ensure that our forces are not surprised, which is provided by battlefield transparency forthcoming out of use of satellite surveillance.

• ***Economy of Effort.*** Concentration of superior forces at the decisive time and place with minimum effort is best facilitated by the use of space-based weapons; actually there is total economy of effort in this case. Once the satellites themselves are secured and protected in their respective locations the commander on the ground does not have to bother about their deployment and redeployment, yet achieve concentration. The traditional handicap that the commander cannot be strong everywhere can now be precluded. Space based systems provide the capability required to operate in such an austere environment without the need to deploy and install networks of ground terminals and relays.

• ***Flexibility.*** The satellite-based military support is available to the commander literally everywhere, hence he does not have to think of regrouping to achieve flexibility. Hence use of space-based weapons provides an inherent flexibility in planning to the land forces commander. Satellites provide secure as well as reliable signal communications, which enhances flexibility. With satellites it becomes easier to visualise and anticipate the changing battlefield. Command and control is facilitated with space-based facilities that further add to flexibility.

• ***Co-operation.*** With enhanced communications and modernised command and control achieved through satellites inter service co-operation is greatly facilitated. The scope of co-operation will be increased to multinational forces. The Army will become more involved with other services, national agencies and nations to protect national interests. The ability of the Army to conduct a wide variety of operations under various command and control relationships will be essential in future operations.

• ***Administration and Logistics.*** Administration is the management of all phases of military operation not directly involved in tactics and military strategy. The object of administration in war is to so arrange the provision of supplies

of all kinds as to give the operational commander the maximum freedom of action in carrying out his plans. The benefits derived from geo-positioning and location requirements in logistic support operations aid in the rapid and accurate distribution of logistical supplies. It would provide for responsive and accurate logistical support requests, planning, directing, processing and delivery, as well as forecasting requirements for logistic support. The concept of 'Focused logistics' becomes feasible with space capabilities. In fact long range weapons operating from air and ground preclude the necessity of leap frogging artillery ammunition etc., thus simplifying the logistics of operations.

• ***Omni-directionality.*** This is a new principle of war, which has emanated recently. Omni-directionality has, by and large, been accepted as a principle specially in view of the pay offs and capabilities of various space systems. The battlefield of the new millennium is no longer going to be linear in nature but will be multidimensional and characterised by simultaneity. The battles will be fought on land, sea, air and space. The availability of better communication, command and control and intelligence systems will diminish the efficacy of hierarchical controls. Therefore, there would be necessity of synchronising all combat assets towards a single direction so as to achieve the cumulative end result. Obviously, it would encompass the complete spectrum of the war machinery *viz* from the electromagnetic span to the foot soldier capabilities.

• ***Partnership and Alliances.*** The future wars will be fought primarily based on partnerships and alliances between multinations as has been amply demonstrated in the Gulf war and also the Afghan war. These will only be cost-effective and without this the independent nations may not be able to withstand the cost of waging a war. These alliances would also encompass satellite as space assets.

• ***Asymmetry.*** The success of operations will greatly

depend upon the asymmetry in planning and subsequent execution of plans. The set piece plans with fixed templates will fail considering the availability of highly improved surveillance, communication, firepower and command and control means to the enemy. Nations who have dominance of space capabilities although being conventionally weak to the adversary will be able to offset the weakness. This has also been amply explained in the aspect of 'Economy of Effort' above. In an asymmetric warfare scenario like the evolving ' Net War' concept could also be paralysed by space prowess.

• ***Centre of Gravity.*** The centre of gravity of wars in the future scenario is likely to shift from military defeat to paralysing the organisational structures, command and communication centres to destruction of economy. The focus will thus shift to targeting intangibles accordingly, including the economy of a nation and isolating it from the rest of the world by severing the communication links of space systems. It will be more prudent to concentrate the forces at the point of decision at the desired time only. Any prolonged exposure of a concentrated force will be a lucrative target for the enemy and would call for collateral damage. Thus the strategy would be to pulverize the nations nerve centres rather than seek military defeat by capturing a physical high value objective. In a future war, maybe after 15 years, the centre of gravity of a war between two nations may shift to space assets of a nation.

• ***Synchrony (Full Force Integration).*** This will entail dispersion of space assets and information throughout the National Defence Structure. In this navigation, weather, meteorology, missile warfare, intelligence, surveillance, reconnaissance and communication spread over many agencies is integrated with command, communication, control, computer, intelligence and information system (C^4I^2 Systems). Synchrony would become the cutting edge in warfare. To achieve the same, force restructuring may become necessary like in the Indian scenario, creation of a

Chief of Defence Staff (CDS) and integration of the Ministry of Defence with the Services.

Momentum/Operational Tempo (OODA Loop Theory)

The outcome of any military conflict will be dictated by the rhythm or rate of activity or operations relative to that of the enemy. These will in turn be dependent upon the speed in decision making, execution of plans and the transition from one phase to another. The dominating manoeuvres will play a pivotal role in maintaining the momentum/operational tempo, which is needed for the success of the operations. The recent American led coalition offensive in Afghanistan has amply shown; as the opposing Taliban entirely collapsed and could not regain the initiative due to the coalition speed and tempo of operations. Space military asset gives the operational tempo by creating overall battle combat superiority in all spheres, partially due to the OODA loop theory, which speaks of a cycle of observation of the target, followed by orientation, decision and immediate response thereto as shown in the diagram (Figure 13), as also enunciated by Colonel Boyd, US Army.

This is more applicable to an aircraft involved in a dog fight, but would be also equally applicable in satellite warfare as well as using the potential of satellite in achieving and providing better combat awareness from a tactical to a strategic level.

OODA LOOP THEORY

OODA Loop Theory can be used to develop a conceptual framework to demonstrate that air and space can be used in synchrony to maximize the mobilization, responsiveness, flexibility and versatility of air and space power to cause strategic level paralysis by continuous cyclic operations. At the strategic levels, space warfare coupled with the information warfare seeks to paralyse the enemy's loop of observation-orientation-decision-action (the OODA Loop).

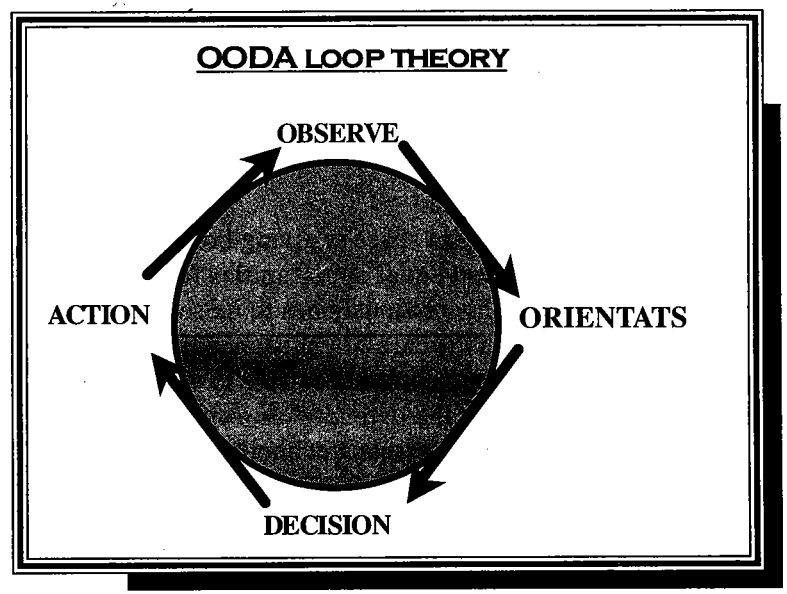

Figure 13

The side which has a weak OODA Loop suffers from the following ailments:

- The opponent's ability to observe is either flooded or very slightly and subtly assaulted by contradictory information and data.
- More importantly his ability to orient is degraded by the assault on the very possibility of objective reasoning as we replace his known universe with our alternative reality.
- His decisions respond increasingly to own fictive and virtual universe.
- His actions within his strategic structures become increasingly paralysed as there is no rational relationship of means to ends.

Therefore, in totality, one can see the strategic evolution of warfare and the art of war, transcending the erstwhile principles and metamorphosing to Net War stratagem dominated by space warfare.

A comparative analysis of some recent modern wars (Kargil, Afghan or Kosovo) brings out some interesting lessons, which should be absorbed and implemented in the change of doctrines and force structures.

Conclusion

The RMA, especially in space is giving both, the defender and the attacker, ample and equal opportunities for exploitation for military purposes. This obviously has to be seized to obtain military initiative, like in the case of Pakistan which has tried to philosophise a Net War, but has not been able to use space assets correctly. On the contrary, the defender, as a state can evolve a 'CNS' with the help of space assets. Yet another facet is the shift in Military Strategy and Principles of War due to the ongoing space RMA. For nations who want to build a modern and cost-effective Army, harnessing space assets, and building a Military Strategy or a National Doctrine would fetch optimum results.

Chapter–V

CONCEPT OF OPERATIONS AND ARMY'S ROLE

- Concept of star wars.
- Pattern of star wars.
  - The satellite phase.
  - Destruction phase.
  - Mopping up phase.
- Spatial tactics.
  - 120 degree angle positioning.
  - Depth.
  - Mutual support.
  - Reserves.
  - Minor tactics.
  - Numerical superiority.
- Land forces role.
- Impact on command & force structure.
  - 'Thin and Flat' command systems.
  - Options.

If one views space from an operational rather than organisational perspective, one is driven to get a vision of an extension of the vertical dimension to infinity. Undoubtedly air power has been the cradle of space exploration; similarly in the later part of the next millennium, space power would become

the mother of cosmic power towards infinity. Nevertheless, the above euphoria, coming down to the present ground level military powers and equations, General Moorman of the US Army had rightly said: "Looking ahead a few years, one can speculate that advocates of both air power and space power will likely be talking of similar issues."[1] Therefore, what could be the visions of space?

Visions of Space

- Space and space weapons will save us from nuclear war.
- Space is an arena in which to engage the enemy, show resolve, and single intent is required with little risk of terrestrial spill over. But in reality space cannot remain immune from the effects of combat originating on earth.
- The Technology of Open Ocean sailing (the compass, sextant, and full-rigged ship) came together only in the late 15th Century and only in the mid-1800s were sailors freed from the whims of winds. Akin projections in concepts can generate similar powers.
- The conquest of air began in 1783, when the Montgolfier brothers flew their first balloon over Paris; it was complete within two centuries. Space is going through a similar cycle.

Military Use

Analysis of land and sea operations and their evolution reflect space as tomorrow's battleground. Space, therefore, is bound to affect and dominate land operations.

- Naval battles have been the pivots of history. Nelson's victory at Trafalgar (1805) assured British naval supremacy and forestalled Napoleon's invasion of Britain. American success at Midway (1942) turned the tide against the Japanese in World War II.
- Some compare space operations parallel to Persian fleet at Salamis, so strategic to wartime operations that US commanders would become non-operational, as Darius was, should connectivity to space be lost. One can foresee by 2050 AD or later, that orbiting fleets and battle-stations,

PRINCIPLES OF WAR

SPACE POWER AND THE ARMY

- Accurately assess the current situation
- Adapt to the demands of the situation, i.e., modify plans
- Anticipate enemy actions
- Act faster than the enemy
- Exploit opportunities and vulnerabilities
- Identify targets for fire support systems

could, like the sea-borne history, play a key role in future conflicts. Similarly aircrafts played a major role in World War I. Initially used against the balloons, the aircrafts soon got into air-to-air combat themselves. By close of the war, these simple aircrafts were joined in by huge biplane bombers, to cumulatively display the theory of strategic air power in 1921. An Italian officer, Giulio Douhet, penned this down. There is thus a kinship between Douhet and modern space power. Earlier, the aircraft waves dictated, starting or terminating a war. In future, space battleships are advocated to nip a nuclear war in the bud, hosing on launch pads, silos and missiles in flight with a wail of fire and create an impregnable 'BMD'.

- Antarctica is the last terrestrial frontier. It was sealed against military activities in 1959. Nevertheless, any military activity from this spot is not considered cost-effective. Can a similar question be mooted for space? Maybe no, as satellite domination is now being considered as an important military force multiplier.
- The breadth of airspace is defined by the outer limit of the territorial sea. The upper reaches of airspace are defended as well, but their limit is undefined. In principle, airspace is infinite.
- For space, the technology threshold is higher and thus

yet not accessible as the other three, i.e., land, air and ice.

Concept of Star Wars

In the case of land centric sub-regional powers, the national aim would be to preserve the land boundaries, unlike the USA and others. Therefore, space potentialities as a concept would have to lend support to ground operations or the Army. Accordingly space facilities would have to be placed in support of the Army. In fact, for better cohesiveness and integration, all weapon systems up to the stratosphere should be placed under command Army and the upper part be integrated with the Air Force command.

The High Ground in Space has following advantages—

- The domination of earth's orbital path and area of influence would be a strategic gain in war capability.
- The domination of moon gives domination over area of influence.
- Command over lunar liberation points (L4 and L5) gives overall command over earth-moon environment.
- Moon remains the astro-strategic cosmic stepping stone into the outer space.
- Outer space domination gives the ultimate external and impregnable defence capability.

Pattern of Star Wars

Star wars would be fought in space with the ultimate aim of victory on ground. Star wars would take three distinct phases—

The Satellite Phase.

This would involve shooting out each other's satellites with a view to gain superiority and freedom of action thereafter. This would involve firing of lasers or ammunition of tremendous velocity at long ranges from 100 to even 10,000 kilometres. The future would also lie in creating reflective shields on satellites against laser weapons or even the designing of anti-satellite

THE HIGH GROUND IN SPACE

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weapons (ASW). The side, which will have the base on the moon, would have a definite advantage due to the celestial deployment in space and the moon's natural balance in the universe.

Destruction Phase.

This would involve destruction of the population, communication and other strategic installations on the earth. The options for doing this would be by—

- Pinpoint engagement of targets by satellites closer to the surface of the earth. This could be done by lasers, particle beam, and proton guns or by X-Ray lasers. A laser beam can damage the target due to high energy range, by either of the methods:
  - By nuclear strike either by an ICBM or by an aircraft.
  - Burning the target area by focusing solar energy on the target.
  - Conventional attack with the aid of satellite lasers in fire support role.

Mopping up Phase.

This would involve physical taking over the territory and capture of the army installations and population with a view to

harness the resources of that country for self-perpetuation and advancement. Conventional forces like the Infantry and Armour would of course do this. Airmobile capability for such tasks would be of paramount importance.

Spatial Tactics

'Spatial Tactics' would imply practice of tactics in space warfare and would be akin to tactics on ground as during ground warfare. It is possible to evolve the basic tenets for spatial tactics by astro-mathematics. However, as a layman, one can only make a beginning as given under—

120° Angle Positioning—

(See Figure 14). Minimum requirement of positioning any type of satellite, space machine or space weapon would be three at an angle of 120° from each other. See A, B and C. This would enable total coverage of the earth surface by direct sight. Going a step further, it will be still better if such systems are yet placed closer at 60° angles as shown by in the illustration. See A1, B1 and C1. This would provide inherent flexibility, and foolproof response with adequate reserves. Because if communications satellite A fails, then A1 can be used, or if laser satellite C is shot down, then C1 can be used.

Depth.

The ideal geostationary orbit is at a distance of 18,600 kilometres from the earth, especially for communication satellites. But putting all the systems only in this orbit would ease the anti-satellite attacks. Thus such weapon systems should be deployed in various orbit heights; like the laser weapons for ground targets could be in the orbit of 300 kilometres from the earth; laser weapon satellites against communication satellites could be in same orbit or higher and solar type weapon satellites could be at 15,000 kilometres. In fact the depth of deployment would be dictated by the type of satellite weapons, the likely type of ground targets

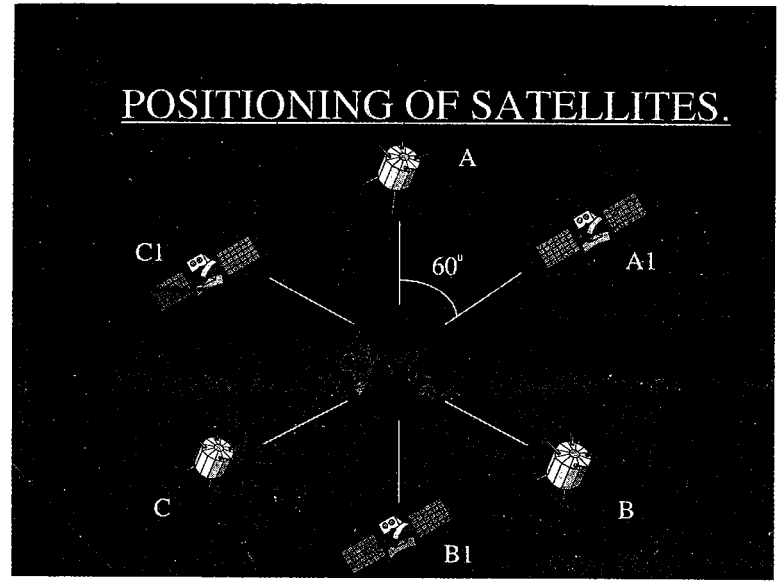


Figure 14

and the enemy satellites configuration before commencement of star wars.

Mutual Support.

In military parlance, it has the same traditional meaning. Anti anti-satellite weapons (AASW) will have to be placed in conjunction with anti-satellite weapons (ASW). For example, in illustration, if A and A1 both are killer satellites, then they could be termed to be in mutual support. In fact the Americans have already tested firing of an ASW, which was fired from an Air Force F-15 jet fighter. Thus the AASW would probably have to have a 'Super Electronic Eye' to strike before the ASW is launched. Many combinations, depending on the weapon capability and the design of battle so planned, would dictate the deployment for mutual support.

Reserves.

Reserve satellites of all types will have to be kept ready on

the ground for a launch if required. They would replace the destroyed satellites.

Minor Tactics.

Even minor tactics would pay dividends. Twin astronauts as a team with space scooters would have to be trained for commando type of raids on enemy satellites.

Numerical Superiority.

Once the star wars starts, it will be a battle for numbers in the first phase. Obviously domination of space to a very great extent would depend on the number of satellites in possession at a given point of time.

Role of Land Forces

The necessity of integrating a wide spectrum of resources above sea level and making them available to the Army for projection of national interest becomes mandatory. The whole structure has to be networked under a unified command of the Army. The role of the Air Force and the Navy would remain subsidiary and supporting only in regions, which have to protect land frontiers. However, if developing nations like in the Asian continent have ambitions beyond the frontiers across nations and trans oceans, then the medium of projection would have to change along with the environment *viz.*, operations on the Pacific rim will require more of air and naval power with Army in supportive role. However, in the existing environment in the South-Asian region land frontiers require more attention and therefore the Air Force and Navy have to be in supportive role. Therefore, military force restructuring would depend on a national perception of threats, either from land or sea and its geo-strategic location based on which, it has to decide on various contingencies of either giving an expanding role to the Army or to the Navy or Air Force. Let us examine the case of South-Asian nations.

The concept of maximisation and synergy demands integrated and unified command. Thus there is a case of enlarging the Army's

resources by vertical integration of tactical missiles, helicopters and fighter aircrafts, at least up to a height of weapons and machines operating up to three kilometres from the surface of the earth. The area of responsibility of the Air Force shifting upwards from Strategic Forces (missiles and aircrafts) to the outer space containing all types of satellite. In fact, the role of satellites would form a strategic arm of the Air Force. This total cohesive strategic Air Force provides the support role to the Army giving it more flexibility and also acts as a force multiplier. For example, early warning and surveillance satellites could give real time information to the Air Force space command and the Army space command or the Army user systems themselves to give instant response. In fact, satellites should have triple connectivity – one going to a command and control satellite, one going to the Air Force space command and one going directly to the Army users like GPS or other online data processing units for direct utilisation. The laser weapons based in space, can also give fire support to a blitzkrieg unleashed by the ground forces after surveillance and complete intelligence data has been fed through satellites and computers, a dedicated wide area network which should be secure and stable; incorporated in the operational manoeuvre plans. The aspect of nuclear thresholds would contain operational objectives to shallow hooks, over a wide front. Multiple shallow hooks would substitute the concept of deep penetration by land forces, so that the total area captured remains the same except in dimensionality. Therefore, the Army will continue to maintain the edge in fulfilling national aims and doctrines with the other including space resources in support with a view to pass instantaneous information about enemy nuclear forces as well, help land forces to achieve limited multiple objectives of shallow depth – keeping just below the nuclear threshold levels.

Impact on Command and Force Structures

The unresisting progress of mankind causes continual change in the weapons; and with that must come a continual change in the manner of fighting. The issues of inter-service command and

control and force restructuring become very important at this juncture, as 'RMA' in the past 2000 AD period would demand major structured changes both in design and perceptions. Future technologies would suggest more 'Thin and Flat' command systems as discussed in subsequent paragraphs.

'Thin and Flat' Command Systems

The impact of advancing space technology similarly will affect the command responsibilities and inter-Service force re-structuring. Delineation in command boundaries is likely to become more blurred as the extents increase manifold. Homogeneity and centralisation in command have to be balanced against proportional distribution of areas, boundaries and resources for effective command. Aptitude and quantum of force projection would thus become key factors in deciding the dividing lines. The concept of 'Thin and Flat' command systems may provide the right mix. The system has to be wide horizontally but thin vertically and make the middle level commanders redundant. All network nodes or command centres be connected vertically and horizontally and change to a system of dispersed command rather than control under a unified, but an unwanted rigid plan. This will ensure all direction connectivity, however the central command node may veto or order change of plan. The overall product would be fast information tracking at the user level at the same time allowing collation for building a macro picture for giving strategic directions. The use of 'GPS' by individual vehicles and sub-units during the 1991 Gulf war was an example of this kind of connectivity. The factors, which may affect delineation of inter-Service command structures as pertaining to our environment for a 'space' culture could be as under—

- ***Command and Autonomy.***

Command and autonomy to the Army over the tactical missiles and Air Force could be a shot in the arms of land forces. (This is already applicable in the United States.)

- ***Centralisation and Decentralisation.***

The resources of space systems would have to be decentralised for 'Information bits' to enable land forces and other user units to benefit directly. However, centralisation for strategic orders i.e. changing location of satellites etc., may have to be centralised, may be under the Air Force space command.

- ***Hierarchical Chains and Overstepping.***

Hierarchical chains of command give the impetus and depth to an operation. This is most suitable in dogged conventional static type warfare, where orders gain strength by repetition through a chain. However in fluid fleeting situations, overstepping by two or three levels above may restore and capitalise exploitation. In the post 2000 AD battlefield, milieu connectivity to enable both will be there and therefore art of command and communication may have to be modified accordingly.

- ***Stable and Moveable.***

Satellites in space have to transmit to ground stations having satellite terminals. By being static/stable and also being portable, such terminals would enhance organisational compatibility for operational manoeuvres—an important factor for consideration.

- ***Those on Land, Air and Space.***

These are the three dimensions of future warfare. Inter-Service command structure should have respective service configuration and connectivity for graduated holistic approach and decision-making depending on the intensity and bias of operations. With the introduction of space assets, respective services connectivity with space command would become mandatory.

- ***Information in Real Time.***

This would become a key factor in tomorrow's IT intensive warfare. Thus integration of various systems in real time for combat decisions would provide assured success. Satellite early warning and surveillance with a 'Line Data Service' would become an important element in command decisions and force structuring inter-service as well as intra-service.

- ***Flexibility and Regrouping.***

Future organisations should be tailored to mission achievements. Add on bricks be created with the parent organisation on tactical and operational need basis. For example, a land offensive, spearheaded by a strike Corps, should have add-ons of space cell to allow a smooth interface of land and space technology. These add-ons would then become force multipliers.

- ***Continuous Command.***

Continuity in command till mission accomplishment is a guideline not to be forgotten even in high technological war, as disruptions do not add to the calculus of futuristic force structuring. Inter-service rivalries on this account should be guarded against. Integration of tactical missiles and aircrafts to the Army would bring home this valued lesson.

- ***Inter-Connectivity and Operability of Various Command and Services.***

The culmination of all command-structured organisations is end result of inter-connectivity and inter-operability. This aspect can be achieved by integrating systems up to the troposphere under one agency i.e. the Army. The systems of higher reaches could be under the Air Force – similarly in the areas of Indian Ocean, these integrations at tactical level can occur with the Navy, where Army would play a subsidiary role.

Options: Delineation of Command

Delineation of inter-service command should match the future battlefield requirements and the threat perceptions against potential adversaries. Do we require strengthening the Army or the Air Force by add-ons or by a method of restructuring and integration thereafter, either by vertical delineation along the line of troposphere or stratosphere or by integrating some element of tactical Air Force with the Army and expanding the area of responsibility of Air Force towards outer space? Or maybe there is a case of instituting a third separate command. The various options are discussed hereafter.

Option 1—Air Force: An Expanded Role.

Due to the expansion and militarisation of space, Air Force be given an 'Expanded Role' and should form the Air Force command headquarters where both the Army and space resources get integrated to the middle layer i.e. the Air Force. This obviously would not suit the Asian sub-continental requirements, which have live borders. However, such an option is most suited to USA and Australia.

Option 2—Army: Integration of Tactical Air Force/Missiles.

The present set-up should continue but Army be given enhanced inter-connectivity and inter-operability combined with real time data accessibility, flexibility, autonomy and centralisation of function are achieved by integrating the tactical Air Force and missile systems with nuclear delivery capability. This option appears most efficient as per the demands of the time. Integration of Army 'Air Op Flights' with the artillery units and Army formations has proved very successful. This philosophy may be now extended to include the tactical Air Force and various short-range missiles in the Army command hierarchy. To this should be added a 'space cell' co-located with the space and Army institutions. This cell be 'IT' intensive and should have functional inter-connectivity with satellites for giving real time information.

The advantages of this option are many and would meet tomorrow's demands of a 'high tech' warfare.

Option 3—Three Separate Commands.

In the existing paradigm of Army, Navy and Air Force services a space command be added as a fourth service. This is a premature stage for this step and may prove counter-productive. USA has been having space commands for quite some time. Asian countries are likely to follow suit.

Best Option.

Option to be decided would vary for nations. In the case of Asian region where nations have vast land frontiers, Option 2 is recommended. Future wars should provide commanders, the tools to conduct full range of operational and tactical operations on the battlefield. The existing nuclear deterrence theory for stability will have to be augmented and supported by all air and land resources, under a unified command. Therefore, force restructuring to this extent may add to the Army's mission achievement and national goals. Concurrently, space systems will have to provide support to these functional areas under the unified command system of the strategic Air Force. All the three Services are integrated under a Joint Land - Air - Space (JLAS) Headquarters under which the present strategic command (being formulated presently) of nuclear forces can continue to function. The National Security Council (NSC) continues to be the apex body for giving all policy decisions. However, the JLAS would do the strategic and operational planning of operations to enable an integrated air-land-space approach. These organisational add-ons may become a necessity in about a decade or so when information technology would be more visible, based on space based systems and more space-related technologies would emerge.

Chapter–VI

EVOLUTION OF SPACE MILITARISATION

(Case Study of Present Day Conflicts)

NEW WEAPONS

- LASER WEAPONS (PARTICLE BEAM/CHEMICAL LASER).
- UHF WEAPONS.
- ULTRASONIC WAVES WEAPONS.
- STEALTH WEAPONS.
- SMART WEAPONS.
- PLASMA WEAPONS.
- SONIC WEAPONS.
- ELECTRO-MAGNETIC RAIL RUN.
- DIRECT ENERGY WEAPON.

"The Gulf war," said Colonel Alan Campen, former Director of Command and Control Policy at the Pentagon, "is the first instance where combat forces largely were deployed, sustained, commanded and controlled through satellite communication."[1] Similarly Sir Peter Ansan and Dennis Cummings of MATRA MARCONI Space UK Limited in Britain said: "It was the first real test under war conditions of the $200 billion US space machine, and the first justification in combat of the $1 billion French and British investments in military space."[2]

The emerging battlefield milieu would be 'IT' intensive which would integrate the functions of individual weapon systems at various strata in the atmosphere starting from artillery guns to precision guided missiles, unarmed aerial vehicles, aircrafts and various surveillance and weapons platforms in outer space into one cohesive force by automated command and control. Each system would be an equal trigger puller with same operational responsibility and a 'Data-Fusion-Technology', which would spell out decision and destruction by the press of a button. Space support systems would reduce ground support systems and thus give more flexibility and accuracy. 'Mini-computerization' will enable 'On Board Processing' by users like aircrafts and missiles. 'Fused Bit-Streams' will allow instantaneous regulation of weather, warning, negation and surveillance and communication. Anti-satellite weapons will be a space superiority weapon and would be critical in the space war phase of operations. Laser platforms from space to ground and from ground to space would be the killer weapons. Following weapon technologies are likely to emerge—

- **Laser weapons (particle beam/chemical laser).** These would employ an intense beam of coherent electro-magnetic radiation at infrared, optical, ultraviolet or X-ray frequencies.
- **Ultrasonic waves weapons.** The weapons which are using the spectrum beyond the speed of sound.
- **Stealth weapons.** The weapons which cannot be detected by radars using stealth technology thus not reflecting the signals back.
- **Smart weapons.** There are preguided bombs which are preprogrammed to reach its target with precision.
- **Ecological weapons.** They use the effect of electro-magnetic field to throw a projectile at fast speed.
- **Plasma weapons.** It uses the fourth state of natural particles beyond the solid, liquid and gaseous stage.
- **Radio frequency weapons.** These would employ an intense beam of electromagnetic radiation at micro wave or millimetre wave frequencies.

- **Direct energy weapons.** These will be line of sight weapons beam tracking at near the speed of light.

Evolution of Space Militarisation

Here is an analysis of the timely record of the technological and political events that form the background of today's urgent debate about military exploitation of space. The early political history illustrates the difficulties encountered in the "international management of 'non-territorial' regions but also the interplay of international rivalry and technological change," as quoted by Lord Zuckerman.

The launch of the first Sputnik in 1957 had started the 'Star Wars'; more than 5,000 objects which include 200 to 300 operating satellites are being constantly tracked by radars in space. The Americans were already by now suffering from inter-service rivalries in the projected arms race. The matter was settled by establishing a civilian-led NASA and each of the service was provided with a piece of R&D pie. In the case of Asian nations that have disputed land boundaries, space operations unlike USA would become more land/border centric and consequently more Army centric. For the Russians, separation of civil and military aspects of space never occurred. The period of 1960s saw the space arms race between the two superpowers reach its pinnacle, as neither side wanted to be outdone by the other. However, the testing of nuclear weapons was fractured by the Partial Test Ban Treaty (PTBT) of summer 1963, followed by a 'Declaration of Legal Principles', governing the use of outer space, which in 1967 became enshrined as the UN Outer Space Treaty, disallowing nuclearisation of space and non-militarisation of moon. But in reality many more countries have joined the fray and have achieved satellite-launching capabilities such as China, India and Israel, Iran and Pakistan. These countries are making rapid progress.

In the USA, Air Force space command was formed in 1982, a Naval space command in 1983 and an Army space command in 1988. The Air Force was the trailblazer, as America's potential adversaries are only approachable by air. Contrastingly, the Army

would have to take the load of the fundamentals of warfare in the South Asian subcontinent. China's and India's fast track progress in space technology (five satellites of INSAT-3 class will be launched between 1999–2003) must be matched by changing dynamics of a 'Force Multiplier' and a mix of nuclear and space doctrines. The relevant issue is of how far a Nation's sovereign territory extends into the sky similar to the rules governing the EEZ in the oceans? These are strategic issues, which have to be formalised by a national doctrine under the aegis of the National Security Council.

The 1972 ABM treaty has been a landmark in curbing an arms race. The SDI, initiated by Reagan also lost as a concept due to the projected overbearing expenditure and a general feeling of getting into an 'un-winnable war situation'. However, the reality remains that countries have made covert progress in militarisation of space. The 1991 Gulf war is only a proof. It has been signified as the 'First Space War' in history. The period in the post-Gulf war scenario has ushered in an irreversible race for space militarisation. In fact, the US Army has several initiatives underway to determine requirements for using the new high ground – space.

As compared to USA, the Russian space programme traces its roots to the active post-war exploitation of German rocket developments followed by Sputnik I and Sputnik II; and the Soviet manned mission into space in 1961. In the case of Soviets, doctrine matched technology and they were quick to exploit space for military and national goals. About 80 per cent of Soviet space programme had a military application. The Soviets had been obtaining the following types of support for military operations—

- Target details.
- Order of battle.
- Force deployment monitoring.
- Situation assessment.
- Geodetic information for tactical nuclear targeting.
- Mapping and position.
- Communications.
- Meteorological support.

The Russian goals, although not public, can be identified as:

- Enhanced space support systems to augment operational and tactical combat superiority.
- Enhanced strategic capability of Russia.
- Continued evolution of sensitive capability.

The evolution of US Army and space warfare relationship can be traced back to the German big range VZ rockets, which sparked the concern over the vulnerability of the Continental United States the defence of which was Army's mission—by being a primary player in the BMD concept. America's first satellite was placed into orbit by the Army's Jupiter C rocket, on 31 January 1958. The 1956 reorganisation brought the rocket research work under the control of US Army Ballistic Missile Agency. Within a decade many missions were launched into space supported by the Army including 'Explorer-I'. Even after the establishment of NASA, the Army continued with introducing viable plans programmed for operational or tactical use of space systems and SOPs for Air-land Battle Support. It is interesting to note that Army BMD programme funding represents approximately 40 per cent of the initial SDI budget. This is an indicator, that although SDI may not exist as an integrated programme, but its sub-systems, in conjunction with the Army, are getting evolved for future military space systems. Therefore, nations should obtain similar parallelism in their future plans itself and should bid for dual use modifications to satellites being launched in the immediate future and even plan a technological leap in the post 2020 AD period. Integration of space technology in nation's doctrine for nuclear warfare, presently being debated should have ingredients of a fifth dimensional force multiplier.

The High Ground in Space

Today, not even United States has declared a long-term space military strategy. However, it will be unrealistic to assume that none is being formulated. In a book written by John Collins,

analyses of the entire earth-moon systems is made in military terms. The book actually deserves a serious consideration. Some analogies, based on a geo-politician Halford J. Mackinder's findings fifty years ago, concluded that "circumterrestrial space... encapsulates earth to an altitude of 50,000 miles or so."[3] The implications are clear and derivates as a prognosis, after seeing the space RMA and the great advancement which even developing nations like China and India have made.

COMPARATIVE ACCOUNT OF DESERT STORM, KARGIL, KOSOVO AND AFGHANISTAN WARS

KOSOVO AND KARGIL

- Both wars happened in 1999.
- One was high-tech, otherwas ancient.
- Common factor: space capabilities-surveillance, command and control, PGMs, navigation & guidance.
- Lesson Kargil: restructure and assimilate space.

Desert Storm: The First Space War

The Gulf war can truly be described as the first successful Space war. Space added a fourth dimension to the war. It influenced the general direction of the conflict and saved lives. Space enabled a fully secure and effective trunk and tactical communications network, large enough to support a 4,00,000 strong Army, to be established in theatre in a few weeks. It provided detailed images of Iraqi forces and the damage inflicted by allied air attacks. It gave early warning of scud missile launches and assisted in launching Patriot missile. Space provided a navigation system of stunning accuracy that touched upon the performance of every soldier; on missiles, tanks, aircraft and ships.

Communications satellites carried the majority of the military trunk traffic (secured speech, data, facsimile) into and out of the

theatre. They provided tactical links within theatre and bridges for other terrestrial VHF/UHF radio systems whose line of sight limitations prevented them from scanning the desert reaches. They provided total communications to ships at sea, to troops on the move and even to military aircraft.

The detailed work of the US, UK and French operational space segments in support of the combat forces during Desert Shield exemplified the inherent capabilities of space communications. These include rapid deployment, high quality of communication, security, reliability, power and flexibility. It also demonstrated the growing military dependence on satellite communications in all services and at every level of command. The defence support programme provided real time intelligence.

Using a hand-held GPS receiver, a ground soldier could locate his position. Using a laser range finder he was able to obtain the range and bearing of the target for relay to an air control officer to provide precise target information for ground support aircraft. These, in turn, using their own GPS equipment, were able to offset their bombing instruments and attack with devastating surprise and accurate precision. Thus, the effectiveness and safety of an $18 million aircraft could be enormously enhanced with a $3000 hand-held instrument with Infantryman. A total of 13,000 GPS were purchased.

Military experts generally agree that satellites helped to win the Gulf war, sustained command and control, shortened the war, and saved lives. Without space communications and navigation, it is difficult to imagine that the war could have been other than even more costly, protracted and bloody.

DESERT STORM

- WARRIOR ARTS BUT IN THE TECHNOLOGICAL, APPLIED SCIENCE, ENGINEERING AND SYSTEMS REQUIREMENT.
- IN THE POST-DESERT STORM SCENARIO, THE EFFECTIVE EXPLOITATION OF SPACE BY US CENTRAL COMMAND (CENTCOM) OCCASIONED A POST GULF WAR BLOSSOMING OF SPACE AWARENESS AT ALL LEVELS, OFFERING UNPRECEDENTED PROMISE.
- 13,000 GPS WERE PURCHASED.
- DSCS SP 129 TACTICAL TERMINALS ON GROUND.
- ONE DSCS WAS RE-POSITIONED IN THE INDIAN OCEAN.
- DMSP PROVIDED REAL TIME MET.
- DEFENCE SUPPORT PROGRAMME (DSP) PROVIDED REAL TIME INTELLIGENCE.

Without high quality space imagery, Saddam Hussein might have gotten away with his mission, given the undisturbed time to build up his missile, chemical, biological and nuclear capability. The Gulf war has also taught the Space Community some sharp lessons. It has shown that the inherent flexibility of satellite communications cannot be brought to fruition unless the ground segment is designed and equipped to exploit it. The war showed that high technology has blurred the distinction between civil and military system. In some cases commercial variant was even proved superior. The Gulf war strengthens the fact that space has changed the nature of warfare.

In the post Desert Storm scenario, the effective exploitation of space by US Central Command occasioned a post Gulf war in blossoming of space awareness at all levels, offering unprecedented promise.

Kargil War: Ancient Warfare

Technology has added significantly to the potential of armies and terrorists. The AK-47 has transformed the total potential of terrorist who has often caused losses to the country's security forces in J&K. The terrorist comes equipped with rapid fire-stand off weapons, high explosives and sophisticated communications equipment. He is highly motivated and often a person conditioned by years of fundamentalist schooling with pan-Islamic motivation.

The Pakistani regulars, in the garb of militants, carried out the limited intrusion, this could have been easily detected if there were military satellite over that area with small resolution, which would have provided the surveillance coverage of the Line of Control and assisted the troops in better border management. There is a requirement of synergising the total effort of space systems, Unmanned Aerial Vehicles (UAV) to aircrafts, both fighters and strategic bombers armed with precision with all weather conventional bombs. This would deter any enemy to carry out such intrusions in future. It goes to the credit of Indian Army that inspite of lack of information about the militants and accurate location of bunkers, the intruders were evicted by using brute force. The job could have been made simpler if there was adequate surveillance, precision guided ammunition, satellite navigation and guidance for Air Force pilots and correct assimilation of space. One of the biggest lesson learnt of Kargil war was to restructure the Armed Forces, have better and reliable intelligence gathering device on borders from airborne means and making use of technology for the ground forces for cohesive integration.

Afghanistan War: Counter Terrorist Warfare

The Afghanistan war has been won by USA by sheer use of massive air power, using B-2 Stealth Bombers, B-52 Bombers, F-16 Fighters, F-14 Tomcat and Tomahawk cruise missiles fired from aircraft carrier, ship submarine guided by space satellite and avoiding the radar.

The Al-Qaida targets, bunkers, command and control centres, air defence network were pounded extensively by US aircraft

for 75 days using 5,000 pounds laser guided GBU 28 Bombs, and 15,000 pound Daisy Cutter bombs which accurately destroyed the hideouts of Al-Qaida and smoked them out from their rock caves, irrigation channels and old disused coal mines.

In two months of Operation 'Enduring Freedom', USA got 90 per cent success in their efforts to remove Taliban from the control of Afghanistan which every critic thought that like USSR, America is going to fight a ten-year old battle. The war was shortened mainly due to the use of high lethality weapons, accuracy and navigation provided by satellite guidance, precision ammunition, use of CIA agents on ground providing satellite intelligence and special forces which acted as force multiplier. Even the Infantryman and special forces had the expertise of space information.

One after the other, cities of Afghanistan like Mazar-e-Sharif, Herat, Kunduz, Jalalabad, Kandahar and Kabul, the so-called fortress fell like pack of cards due to heavy and accurate US bombings and the air power played a decisive role in delivering its long awaited promise of Battle Winning Factor.

After 11 September, the US has invested millions in the Signal Intelligence (Sigint) project. Having failed to track hundreds of e-mails exchanged between the hijackers before the attacks US has now focused eight spy-satellites which will capture radio signals and relay them to earth stations. (Figure 15)

Kosovo War

The Kosovo war was fought in 1999 at the same time when Kargil war was fought by Indian Army. The USA F-16 and NATO forces aircraft engaged the targets on ground with accurate precision for 78 long days and night. The common factor was the use and non-use of space capabilities by two sides. One was a high technology war, wherein all the facilities of navigation, guidance, surveillance and assistance from computerised command and control centre was available to NATO forces and in Kargil all these modern factors were missing.

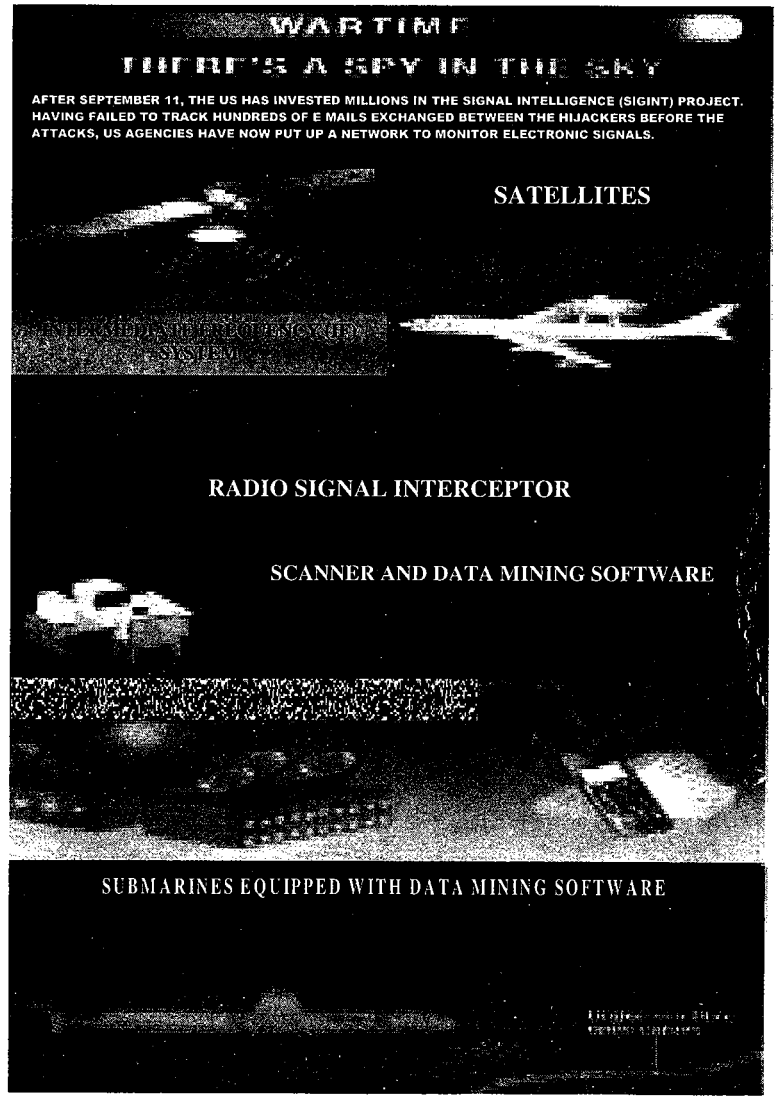


Figure 15: Spy in the Sky

In Kosovo, US forces had the distinct advantages of two decades of fast pace technological advancements made in the critical areas of communications, intelligence, air defence suppression and a sophisticated air doctrine. The US battlefield sensors proved effective even in the effect of smoke.

Raid on a Militant Hideout

Satellites have even helped raiding on a militant hideout as shown schematically in Figure 16, in which helicopters, satellites and special force (commandos) are all integrated in this operation of raiding a militant hideout.

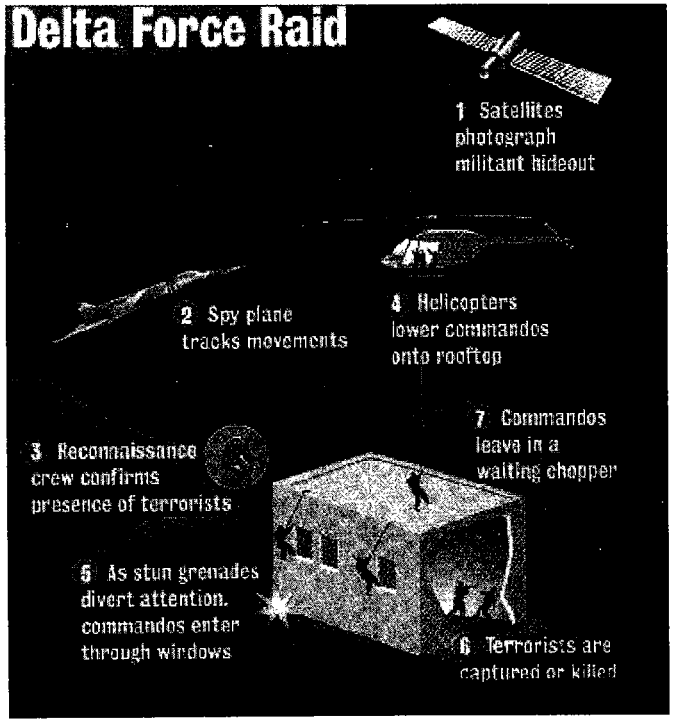


Figure 16

Lessons Learnt for Future Military Forces

There have been many lessons learnt from these wars.

- ***Technology Advancement.***

The future warfare will be fought in the backdrop of enhanced technology that will assist the aircraft and missiles for accurate and precision engagement of targets without risking pilot's lives. Afghanistan war should be classified as the first anti-terrorism war between technologically oriented US led forces against inward looking cavemen in the form of Al-Qaida and Taliban terrorists. An organised technology oriented force against an ill organised force.

- ***Satellite Communications.***

Management of space segment of satellite communications is a complex and lengthy process which must be done by network of management experts for its real time utilisation as done by USA when it refocused number of satellites on Afghanistan.

- ***Intelligence.***

The requirement of real time intelligence from the processing centre to low level combat forces cannot be ignored, like intelligence to special forces for destruction of Al-Qaida command and control centre.

- ***Firepower.***

In a non-nuclear war, even the conventional bombs like Daisy Cutter will have devastating and lethal effect to destroy any kind of field fortifications. The inward move towards caves and subsequent destruction by high technology Daisy Cutters and laser bombs highlights the neglect of total understanding of high technology by the Taliban. Terrain if not utilised in a five dimensional scenario cannot be expected to pay dividends.

- ***Air Power.***

In any future engagement the air power will totally saturate the target area and reduce the will of defender to fight. Decisive role of air strikes using high technology weapon systems in degrading enemy's command, control, air defence and communication systems has been reinforced after 'Operation Desert Storm'. Consequent effect on morale of troops, which could totally

disorganise a force, is a major lesson.

- ***International Alliance.***

To cut-off any reinforcement of men, material, weapons and logistics, it is mandatory to forge an international alliance before isolating and fixing the enemy, as was done through Northern and Eastern alliance from Central Asian Republic (CAR) and Pakistani side. Similarly forces from the UK, France, Australia and Germany joined in the battle.

- ***Convergence of Aim.***

The political, diplomatic and military aim must converge to a focal point of gaining total success in war.

- ***Fortress Mentality.***

Dispersion of forces in small well knit team is an answer to escape heavy air power destruction. Occupying fort like in Kunduz Fort are the lucrative target.

- ***Occupation of Bases.***

Before the main campaign begins it is a prerequisite to occupy bases and airfields in the close vicinity of target area, for troops and logistics induction like capture of Jalalabad airfield.

- ***Dispersion Versus Concentration.***

The strategy of concentrating in major towns, which goes against the basic tenets of guerrilla/insurgency tactics for which Taliban and Al-Qaida had been raised created concentrated targets for air bombardment.

- ***Psychological Aspect.***

Large scale defection and Afghan psyche probably forced Taliban leadership against breaking up into smaller teams, merging with local population and subsequent prolonged attrition policy through 'hit-run tactics', so effectively used against Russians. Taliban lacked organisational strengths and necessary communication devices to put their strengths to effective use.

Chapter–VII

A COMMON NUCLEAR AND SPACE DOCTRINE

- DETERRENCE.
- CREDIBILITY.
- STABILITY.
- ASSURED DESTRUCTION STRATEGY.
- FIRST-OR-SECOND-STRIKE CAPABILITY.
- ASSURED DESTRUCTION THEORY.
- FLEXIBLE RESPONSE.
- FLEXIBLE TARGETING.
- SPACE DETERRENCE.

A nuclear doctrine exists for nuclear wars (NWs). No space doctrine has been even thought of. There is need for introspection and for combining the space and nuclear doctrine as a projection of national will power. Deterrence is the pillar of a nuclear theory based on preservation instinct and the fear of annihilation. Space based theories may be more 'IT' intensive coupled with limited area destruction due to space based 'Directed energy' application. An examination of both doctrines reveal that their dual integration in the right proportions would serve the strategic goals more efficiently for global security. Only some of the important aspects for such a doctrine are annihilation oriented.

Space and nuclear warfare tend to merge and become

interdependent. In fact, tomorrow's nuclear war would slant towards flexible response by fourth generation system. This perforce would require assistance from space. Space based assets would become the 'eyes' and 'ears' of employing nuclear weapons pinpointedly with lesser collateral effects. Analytically, the nuclear war would ascend to the orbiting space platforms and assist in its guidance.

Nuclear Doctrine

Nuclear doctrine is based on deterrence and many other facets, like that of credibility and 'Mutual Assured Destruction' (MAD) philosophy. Both of these could be categorised as the key factors to deterrence and stability. Credence is added by capability and the command and control element. Therefore, a balanced nuclear doctrine should have all these ingredients to provide an effective strategic deterrence capability to a nation.

Deterrence.

Although, covered earlier, this requires re-defining with a space perspective. Deterrence simply means: making sure any adversary who thinks about attacking our vital interest does not do so if the risks to him outweigh any potential gains. Once he understands that, he won't attack – space capabilities add to deterrence value. As a general concept, and space deterrence is relatively simple, yet it quickly becomes a complicated issue when applied to specific situations and strategies. Space deterrence involves presenting the opponent with a prospect of costs and risks that outweigh his prospective hopes for gain. This is not nearly so easy as it might sound, for calculations of power lack mathematical rigour. They depend on human perceptions, which are subject to interference from emotions like hope and fear. But to the extent a sober assessment of what contributes to successful deterrence is possible, it must focus on two critical characteristics of deterrence: credibility and stability, both of which get added credence with the added space capability.

Credibility.

A credible deterrent is based on two fundamental criteria: capability and will. A nation's capacity to deter an enemy is determined by the means for defence at its disposal and space capabilities. Without sufficient space capabilities, a state's ability to deter attack is not credible in a post-2010 AD scenario. A nation may have thousands of nuclear weapons, but if they are destroyed on ground by space-based pre-emptive strike the credibility rating comes down.

During President John F Kennedy's first year in office, his administration sponsored an invasion of Cuba that failed miserably. Some charged that the failure was due to inadequate US support, and that America's enemies would interpret the failure as a reflection of weak US resolve. US prestige suffered badly, Kennedy's critics argued, and by extension, so had US credibility. Kennedy responded to these critics by asking, "What is prestige? Is it the shadow of power or the substance of power?" Kennedy's rhetorical questions implied that he believed capabilities are the substance of a nation's power, and a nation's apparent willingness to use those capabilities is of peripheral concern for deterring aggression. Space capability is tomorrow's war-winning asset and an important factor for credibility.

Will is a less tangible ingredient of credibility than military capability, but it is no less important. An imbalance in will (i.e., determination) helps explain why a country far superior to another in capabilities cannot always coerce or deter the apparently weaker state. In retrospect, Dean Rusk (former Secretary of State and a major architect of America's Vietnam war policy) suggested that a disparity in will at least partially explained the failure of the United States in the Vietnam war: "Personally, I made two mistakes. I underestimated the tenacity of the North Vietnamese and overestimated the patience of the American people." Although will is probably the more difficult of the two to estimate, both capability and will are subject to misperceptions. Hence there is a third factor critical for credible deterrence, as former Secretary of State Henry Kissinger has noted. Deterrence requires a

combination of power, the will to use it, and the assessment of these by the potential aggressor. Moreover, deterrence is a product of those factors and not a sum. If anyone of them is zero, deterrence fails.

Even if a nation has both the will and capability to punish an act of aggression, but does not successfully communicate these facts to the aggressor, deterrence could fail. Successful communication of will and capability to a potential enemy is complicated by the fact that capabilities and will interact, each influencing perceptions of the other. For discussion purposes capability and will can be considered separately, but in their historical context they are always linked.

The definition of credibility takes a more precise meaning with the introduction of space assets as it adds power to the nuclear command and control systems and augments the will to use due to higher reliance, surety and back up by C^4I^2 systems, which are great force multipliers. Space power also ensures credibility of survival of space assets like battle stations, ASWs and AASWs.

Stability.

A stable space deterrent posture presumes a credible deterrent, but it also presumes that defence preparations will not be overly threatening and thus invite pre-emptive attack. In other words, a nation needs enough demonstrable capability and expressed will to deter an enemy, but not so much that the enemy is frightened into attacking before its security situation deteriorates further. Thus, the case for non-militarisation of space that otherwise will only cause acceleration of arms race in space and beyond. A classic example of a nation frightened into a pre-emptive strike occurred in 1587 when the Englishman, Sir Francis Drake, sailed into the Spanish harbour of Cadiz and destroyed a sizable portion of the Spanish Armada, a fleet that England rightly feared was being prepared for an invasion of the British Isles. England also launched a surprise naval strike in 1807, destroying the Danish fleet at Copenhagen. The danger presented by the Danish fleet is not so clear in retrospect as that of the Spanish Armada, which

illustrates how subjective assessments of immediate threat can be. Nuclear deterrence should build stability. However space based deterrence may destroy stability, as Weapons of Mass Destruction (WMD) may then become absolute as a trend. Further, with the ongoing RMA in BMD systems, the nuclear deterrence syndrome is likely to be replaced by space deterrence and stability.

Assured Destruction Strategy.

It was a custom with the Tauri, people of Scythia, always before a battle to dig ditches, throw up mounds, and render the ground impassable behind: that conscious of their retreat being thus cut-off, they might know no alternative, but victory, or death. Assured destruction strategists have always begun with the premise that nuclear weapons have revolutionised strategic thinking. Bernard Brodie is quoted most frequently on this point. After the bombing of Hiroshima and Nagasaki in 1945, he observed that "everything about the atomic bomb is overshadowed by the twin facts that it exists and that its destructive power is fantastically great." As a result, the whole character of war as a means of settling differences has been transformed beyond all recognition. Thus far the chief purpose of a military establishment has been to win wars. From now on its chief purpose must be to avert them. It can have almost no other useful purpose. Brodie was the first to claim that nuclear weapons broke the previously necessary linkage between deterrence and defence. This assertion requires closer scrutiny since it is a fundamental premise of the assured destruction theorists. To this, add the space dimension of assured strike due to a reliable estimate of penetrating through hostile ABM/BMD systems. However, asymmetry is likely to emerge if one side takes a wide technological leap in space, disallowing the other to land his nuclear weapon.

First- or Second-Strike Weapons.

The offensive/defensive distinction is still a central feature of most disarmament plans, (and flexible response strategies) but it is less important in arms control debate. Like assured

destruction strategists, but for different reasons, arms controllers are more interested in deterrence than defence. Arms controllers generally believe that most, if not all, weapons can be employed in either an offensive or defensive mode, although they may be much more effective in one or the other. Thus arms controllers tend to focus on whether a weapon is more offensive or defensive. They do not seek to eliminate offensive weapons, but control the composition of forces to make war less likely. In other words, they move from the question of defence to deterrence, and consider whether weapons have first-strike or second-strike capabilities. In general, a first-strike weapon is any weapon that is vulnerable to quick strike, yet is itself lethal if used quickly. Such weapons must be used before they are destroyed, and thus in a tense situation they encourage a state to strike first. In contrast, second-strike weapons are not vulnerable to quick strikes, nor can they strike quickly themselves. Space EW systems and weapons will destroy a nation's first-strike capability due to better battlefield transparency and PGMs.

Assured Destruction Theory.

The origin of the term 'assured destruction' reflects the assured destruction theorists' concern that there be no delusions about the catastrophic results of any nuclear exchange. The term (assured destruction) was first used in 1964. The concept was originally to be known as assured retaliation, but this was felt to be too bland. The harshness of the term and the inescapable tragedy described in its definition were intentional. McNamara (then Secretary of Defence) was concerned that, through euphemistic language, the circumlocutions endemic to military briefings and ill-disciplined logic, the Air Force and its congressional supporters were deluding themselves into believing that there was a tolerable way of fighting a nuclear war. Talking, for example, about 'urban-industrial fatalities' rather than 'people killed' cushioned the senses against any attempt to comprehend the extent of the human catastrophe inherent in any nuclear war. Assured destruction theorists stressed there was no possible defence against or with

nuclear weapons, and they strongly discouraged speculation that obscured this reality. It took about a decade for the assured destruction theorists to gain the upper hand in policy circles. By 1969 mutual assured destruction was the official US strategic policy.

The policy principles of SALT I signed in 1972 stated the need to:

- Retain the mutual vulnerability of civilian populations by not providing for their defence.
- Retain the mutual invulnerability of strategic offensive forces through negotiations or some defensive measures.
- Retain the capability and will to respond to an enemy nuclear strike by inflicting unacceptable damage on the enemy's society.

Flexible Response.

Nobody is driven into war by ignorance, and no one who thinks that he will gain anything from it is deterred by fear. The flexible response theorist rejects the premises, and thus the policy prescriptions, of the assured destruction theorists. Flexible response advocates argue that the premises underlying assured destruction strategy are based on a historical myth, and that even considered in the abstract, assured destruction is not a credible strategy of deterrence. The first point, that the precepts of assured destruction strategy are a historical myth, is important because interpretations of historical precedents are used to justify or attack various policy prescriptions in the perennial debates over deterrence strategy. Assured destruction advocates have their interpretation of the historical significance of nuclear weapons, which has been reviewed. Flexible response advocates believe assured destruction theorists misrepresent the historical record on nuclear deterrence. They frequently try to set the historical record straight before arguing their case for a different nuclear deterrence strategy in the abstract.

Space capabilities augment flexible response capability and thus create a state of limited nuclear deterrence. They would usher

in a period of TNW without any collateral damage.

Flexible Targeting.

Space gives the added flexible targeting capability. Looking back historically – most flexible response theorists concede that the assured destruction advocates won the war of words in the 1960s. In fact, assured destruction became so widely accepted that most people today are unaware that there ever was an intense debate between the two schools of thought. However, flexible response theorists assert there has been a major difference between official explanations of policy, which on balance were more supportive of the assured destruction viewpoint, and the implementation of policy, which actually has increasingly reflected the concerns of the flexible response theorists.

In summary, the flexible response theorist argues that assured destruction strategy has been promulgated by official US government sources, but that in force doctrine, posture and deployment is a historical myth. The United States has always been prepared for discriminate use of nuclear weapons rather than a reflexive mutual and complete destruction of the United States and an adversary's society.

Since, according to flexible response theorists, there has always been a mixture of offence and defence in nuclear deterrence strategy, the SALT I protocol that limited ABM deployment did not expunge defence from the deterrence equation as is popularly supposed. At most SALT I was an acknowledgment of the transitory offensive superiority of ICBMs. It was to be expected that this offensive superiority might pass away, which many flexible response theorists think has come to pass with the development of SDI.

Even more to the point concerning deterrence strategy, it follows that flexible response advocates also disagree with the assured destruction position that there is no meaningful distinction between counterforce and countervalue targeting. They agree that a nuclear strike on military installations would certainly entail much 'collateral' damage to urban populations, but it would

certainly be far less than a direct strike on a city, and thus they believe that the difference between counterforce and countervalue targeting is worth preserving. Notice that in making this argument the flexible response theorist is assuming escalation can be controlled (which is denied by assured destruction theorist) and that the environmental side effects (the nuclear winter thesis, for example) of a limited nuclear exchange would not be catastrophic (again denied by the assured destruction theorist).

Flexible response theorists argue that if the distinction between counterforce and countervalue attacks was not really meaningful, or if assured destruction advocates really wanted to ensure that there could be no distinction between counterforce and countervalue targeting, the logical (if not politically feasible) policy would be to place nuclear missile in the middle of large urban concentrations. If US nuclear forces were all located in or near major urban concentrations, an attack on US missiles would necessarily be an attack on the US population as a whole, and the United States would have no choice but to respond accordingly—the preferred deterrence posture of the assured destruction theorists. Majority of the US missile-fields are not located near the largest population centres and could be attacked without maximum damage to major cities.

Space Deterrence.

Space gives the capability of reducing nuclear deterrence theory and thus gives the technological edge the final say. Therefore, in the new millennium an integrated space-nuclear doctrine would automatically evolve. A nuclear power without space capability is like a blind man with muscles. On the contrary, a country with space capabilities can take the defensive action of neutralising the nuclear missile, mid course during its flight. Therefore an integrated space-nuclear doctrine is a transitory doctrine of the new millennium, the culmination of which would be space based DEWs, which will make nuclear weapons redundant and an absolute concept. There will, therefore, be a trend towards nuclear disarmament by 2010 AD or so and that miniaturised nuclear

weapons only up to 1 KT may remain operative. Manning of moon would be the order of the day in which 'Lunar Strategy' would replace 'Nuclear Strategy'. The basic principles of 'Space Doctrine' would enunciate—

- Use of minimum fractional nukes causing no collateral damage. Thus destroy only a limited hostile target.
- Credible ABM/BMD systems should be the backbone of such a doctrine.
- Robust C^4I^2 system to support real time command and control (Integrate space and nuclear resources of land, sea and air).
- Minimum deployment of satellites, ASW and AASW, below the decided levels as dictated by a disarmament conference.
- Joint exploration of moon, for common good of man should be a moot point in the doctrine that would entail denial of right to militarisation.
- NFU of space weapons, however counter city retaliation by DEWs if necessary as second strike.
- Maintain wide spectrum of response, if necessary.

Chapter–VIII

BALLISTIC MISSILE DEFENCE

The issue that has generated a powerful input in the international arena is that of the Ballistic Missile Defences (BMD). The US determination to operationalise a National Missile Defence (NMD) system to protect itself from errant incoming missiles launched from a state of 'Proliferation concern' or 'Rouge states' as also a Theatre Missile Defence (TMD) systems for its friends and allies in Europe and Asia, threatens to throw the traditional concept of nuclear deterrence out of gear.

After nearly twenty years of initiation of Strategic Defence Initiative by the Reagan Administration in March 1983 and since the time the initiative first impinged on the global consciousness, the world is witnessing the birth of a deadlier, more menacing arms race on a planet already reeling under the wounds inflicted by the 20th century.

With the earlier violation of 1972 ABM Treaty by the US itself and now with the recent withdrawal from the same by the Bush Administration in his recent statement in White House on 13 December 2001, the ABM Treaty has been more or less abrogated. Hypothetically, now every convention, treaty and protocol would stand (potentially) abrogated; and the consensus built up painstakingly over half a century would be destroyed, leading to global anarchy on a scale which would have been difficult to comprehend in the century we have left behind.

The ABM Treaty prescribes format for Ballistic Missile

Defence (BMD). It is perhaps predictable, therefore, that the developments by the United States and erstwhile Soviet Union in the field of BMD have been remarkably similar. Both sides have produced ground-based high-acceleration missiles armed with nuclear warheads designed to destroy incoming ballistic missile warheads in the later stages of their trajectory.

The Spartan and Sprint missiles deployed by the United States in 1970s are ground-based high-acceleration missiles and are directly comparable to the Russian Galosh and Gazelle missiles. The difference is that the United States decommissioned its missiles in 1976 and has not replaced them, while the erstwhile Soviet Union retains both types. So, although there is a common approach in employing missiles for both ASAT and BMD purposes, other modes of attack would have to be used to extend the vulnerability of the warhead beyond its terminal descent to the target.

It might be imagined that the task of attacking an ICBM, or one of its warheads, is similar to that of taking on a satellite. However, while there is some similarity in part of their trajectories, they are fundamentally different targets both in their construction and in the threat, which they pose. The methods of ASAT attack have already been described and to date these are not constrained by treaty.

The Strategic Context

For nearly four decades, the erstwhile communist Soviet Union, with its formidable conventional and nuclear might, had remained the single most crucial defining feature for the US. All its policies – security, military, political and economic – had hinged on two objectives: one, to undercut Soviet influence where it existed: and the second, to prevent it from spreading to newer regions.

However, the dissipation of the erstwhile USSR and an improvement in strategic relations between the US and Russia have now freed the US enough to dwell upon other issues of concern. The most palpable and real issues of concern for US is believed to be the threat from the proliferation of weapons of

mass destruction (WMD), including missiles capable of threatening the American mainland and its allies. Bush Administration identified countries such as Iran, Iraq, North Korea and Libya as states of proliferation concern. With the change in the nature of threats, the US has perceived a need to change the nature of its earlier security strategy from purely offence to a mix of offence and defence. The Clinton Administration on 22 July 1999 signed this into law as the National Missile Defence Act. It confirmed the US Policy to "deploy, as soon as it is technologically possible, an effective NMD system capable of defending the territory of the US against limited ballistic missile attack." In May 2001, President Bush also lent his complete support to the NMD and declared it as the cornerstone of future US Security Strategy.

The emphasis now is on constructing a new security paradigm. As President Bush put it: "We need new concepts of deterrence that rely on both offensive and defensive forces." He has hinted at three main planks of new security architecture: "active non-proliferation; counter-proliferation; and defences." As far as non-proliferation is concerned, it has been a long held objective of the US. It has been pursued through the establishment of regimes such as the nuclear Non-Proliferation Treaty (NPT), the Comprehensive Test Ban Treaty (CTBT) and the Fissile Material Cut off Treaty (FMCT). It is the failure of the NPT that the nuclear weapons and/or their technologies have today become available with countries that are non-nuclear weapon states (NNWS) parties to the treaty, and hence legitimately prohibited from acquiring and developing the same. As regards the CTBT, the denial of ratification to it by the US senate has virtually spelt its death knell. The FMCT is nowhere near conclusion. In fact, negotiations remain stalled mainly owing to the different perception of how the NMD would eventually lead to the next phase of militarisation of outer space.

Missile Defences

Predominant wisdom on missile defences during the cold war years was based on two broad assumptions. One, that a national

missile shield that could blunt a large-scale attack had a destabilising influence on the strategic balance. Second, it was presumed that the deployment of such defence systems would trigger arms race in the upgradations of offensive capabilities in a bid to attack the other's perceived sense of invulnerability. Besides these two assumptions, an another front, the technological feasibility of the BMD, was also in doubt, especially since the threat to be catered for was not a country with a few missiles but the erstwhile USSR that had thousands of warheads and formidable delivery capability. With this view, Washington preferred deterrence to defence. It was in this context that the US and the erstwhile USSR had signed the ABM Treaty in 1972. It prohibited the deployment of strategically significant ballistic missiles defences that could erode each other's nuclear deterrent.

Consequently, in the new post cold war context, the concept of NMD has reemerged in a transformed strategic environment, with a new mission, against a new kind of a threat, and equipped with newer advancements in technology. While the Pentagon has demonstrated the basic feasibility of the hit-to-kill concept, not all test have succeeded in intercepting an incoming missile. Several technical problems still underlie an effective NMD system that would be required to detect an offensive missile launch, track the missile in flight and finally intercept and destroy the missile or the warhead(s).

As per the director of the US Ballistic Missile Defence Organisation, General Ronald Kamish, the technologies presently under development will only be able to defend against incoming missiles in their terminal stages. However, the US hopes that by the first quarter of this new century, the country would have mastered the capability to build sophisticated ground based radars as well as a new space based missiles tracking system that would be able to kill an enemy missile in mid course while it is still cruising towards the target.

BMD: Basic Features and Mechanics

- Weapon types.
- Weapon Applications.
- Surveillance.
- Target Discrimination.
- Pointing and Tracking.
- Kill Assessment.
- Battle Management.
- Countermeasures.

Weapon Types

The SDI has brought about a remarkable disclosure of the means by which strategic defences might enhance US national security. This is unusual as concepts and research for such sensitive matters normally remain highly classified and are pursued behind dense veils of secrecy. It is this openness on the part of the United States that allows an early discussion of the methods, which might be adopted if enhanced strategic defences are to be deployed in the future. Lest it be thought that the SDI is solely a Western pursuit, it is worth recalling the words of Mr. Gorbachev, General Secretary of the Communist Party of the Soviet Union, in a TV interview on 30 November 1987. While discussing the SDI he said, "Generally, it's difficult to say what the Soviet Union is not doing. It is doing virtually everything that the USA is doing. Very likely we are engaged in research, basic research, which relates to those aspects, which are covered by SDI in the USA."

Weapon Technology for BMD

- Chemical Rockets.
- Electromagnetic Rail Gun.
- Lasers.
- Chemical Laser.
- Excimer Laser.
- Free Electron Laser.
- X-ray Laser.
- Particle Beam Weapons.

Weapon Applications

From the description of the weapon technologies it is apparent that they can be divided into two separate categories: ground- and space-based. Kinetic Kill Weapons (KKWs) and lasers could be in either category, but X-ray lasers and particle beam weapons must be deployed into space to be effective. The basing of these potential weapons in turn defines the part of a ballistic missile trajectory against which they might be used. Ground-based KKWs could be used to attack incoming warheads in their terminal and late mid-course phases, while space-based KKWs might be capable of attacking ballistic missiles earlier, even in the boosts phase, providing a great advantage to the defending side. While ground-based lasers could also be used in the latter part of the trajectory reflecting their energy from space-based mirrors onwards to their targets could markedly increase their effective range. Alternatively, lasers could be placed in space where, if the laser wavelengths can penetrate the atmosphere, potentially they could attack ballistic missiles or their warheads over their complete flight path.

Surveillance

To bring ABM weapons to bear requires a high order of detection and surveillance of the missiles. Launch detection satellites at synchronous altitudes already maintain watch for launches from large areas of the earth's surface and these systems may suffice to provide the early warning and initial surveillance. However, after the boost phase, when the large infrared signature of the booster rocket has died away, a different form of surveillance is needed. With considerably reduced infrared energy associated with the post-boost phase, the target's temperature more closely resembles that of its background and the problem of surveillance is increased. Longer-wave infrared sensors are needed and they must track every potentially offensive object, including opposing satellites, which could be supporting the attack, to yield the necessary information to marshal an effective defence.

Additional surveillance can be provided by ground-based radar and optical means, the latter being subject to interference

from cloud and precipitation. Space-based radar is a possibility but there are many difficulties, primarily heavy weight and high power requirements, to be overcome before this could supplant the more developed techniques of the ground versions. Infra-red sensors need not be space-based, and indeed the United States is developing a Boeing 767 aircraft, known as the AOA (Airborne Optical Adjunct), modified to carry long-wave infrared sensors.

Discrimination

It is not sufficient merely to survey the threat cloud of boosters, warheads and their associated penetration aids. There must be a process of discrimination between the threatening warheads and the unimportant objects to identify the targets and to avoid wasting weapons. Continuous high-resolution surveillance may simplify the discrimination task by detecting, for instance, the inflation of decoy balloons. Alternatively, the objects might be precisely imaged by laser radar (ladar) employing a low power visible or ultraviolet laser beam with the reflected light being detected by a telescope. Another research technique involves the use of a low power neutral particle beam to impinge on targets and measuring the form of the reradiated energy. Any hint of Gamma or X-ray radiation confirms the composition of the target as a warhead rather than decoy.

Pointing and Tracking

Having detected the targets it will be necessary to aim the weapons and continue to track the targets until they are neutralised. The challenges of pointing tracking differ with the type of weapon. It may be sufficient to point KKWs towards their targets and allow in-built homing sensors to complete the task. For laser and particle beam weapons it would be necessary to track the target and point the weapon for a finite time to allow the energy to achieve the desired level of damage. An impression of the enormity of that task can be gauged by recognising that the target may be only a metre or two across and may be several thousands of kilometres away. Imagine tracking a dustbin-sized object moving

at 20 times the speed of Concorde at a distance equal to the breadth of the United States.

Kill Assessment

Ignoring the complicating factor of discrimination between warheads and penetration aids, it is clearly necessary to avoid wasting weapons by targeting 'dead' warheads. This implies a requirement for kill assessment, the difficulty of which is dependent on the type of weapon employed and to some extent on which part of the missile trajectory it attacks. The use of KKWs should simplify that assessment, as collision with a target at a closing velocity of several kilometres per second should cause it to explode or divert markedly from its necessarily accurate flight path. Lasers and particle beam weapons might cause catastrophic and easily discernible kills but could also cause damage, which is not detectable. Although structural damage or impaired electronics might render an RV unable to survive reentry or to attack its allocated target, it may have to be engaged again because of the prevailing uncertainty. Even apparent break-up of a target could be a programmed action by the attacker as a form of deception with the first hint of interference. Thus, it is likely that kill assessment could be straightforward in the boost and terminal phases but in the intermediate phases it may remain a serious problem.

Battle Management

The requirements for surveillance, discrimination, pointing and tracking, and kill assessment all point to the need for an overall management system to ensure that all or most of the threatening elements of attacking ballistic missiles are detected and defeated. Obviously, this control must be achieved in the most efficient manner to take advantage of the finite number of sensors and weapons and the limited power and fuel available. Many argue that battle management of an overall defence would be a much more difficult proposition than the provision of the other elements of the system's hardware. They may be right,

because virtually every component could be tested in advance but not the integrated operation of the whole.

The task of battle management would be to provide functions for each defensive layer and also to link those layers. Each of them would need to acquire, track, discriminate, allocate weapons and evaluate success before passing its 'picture' and assessments to the succeeding layers, co-ordinate the handover between layers, ensure the survival of the defensive system without compromising the main aim of defending the targets of the ballistic missiles, and provide the overall status to the human controllers.

Countermeasures

In describing the method of operation of each of the parts of a possible system to defend against a large-scale attack by ballistic missiles, it will be clear that the provision of a countermeasure to each and every part could be developed. In case that observation is thought to be an immediate undermining of such defences, it must be recorded that a number of those countermeasures bring their own penalties of expense and technical complexity to the attacker.

The defensive leverage obtained by successful attack in the boost phase could be reduced if the length of the boost phase could be shortened by the use of 'fast burn' missiles. Most current ballistic missiles burn for about 300 seconds but the United States' MX ICBM burns for only about half that time. If the boost phase could be shortened and the height at which it is completed can be markedly reduced, then not only is the period of this most vulnerable phase abbreviated but also the attention of success in the boost phase is increased. Many more defensive weapons would be needed as RVs are deployed and target-numbers proliferate.

The old adage that attack is the best means of defence could be applied to protection of the attacking ICBMs by attacking some or all of the components of the defences. For example, a defensive constellation could prove vulnerable to ASAT weapons. It could also be attacked by space weapons of the types already described which might have long been in space or launched as a precursor to

the launch of its ballistic missiles. Thus the effectiveness of defences in the face of countermeasures will rely on an intelligent estimate of the potential adversary's capabilities during the development stage. Thereafter, they would have to be modified to keep at least abreast of the opponent's anticipated advances.

STRATEGIC DEFENCE INITIATIVE (SDI) AND NMD

The whole concept of defence against ballistic missiles was placed under the microscope following President Reagan's SDI speech on 23 March 1983:

> *"What if free people could live secure in the knowledge that their security did not rest upon the threat of instant US retaliation to deter a Soviet attack, that we would intercept and destroy strategic ballistic missiles before they reached our own soil or that of our allies?"*

In that speech he was, in effect challenging the United States technology base to do the necessary research to find a means to 'free the world from the threat of nuclear war'. The initiative appeared to be a profound moral stance against deterrence of aggression through the promise of retaliation. It may, though, have had a more practical foundation—a recognition of the developments in erstwhile USSR offences and defences. Accuracy of their ICBMs was being improved so that they were approaching a disabling capability against the United States land-based strategic systems. Those ICBMs themselves were also becoming less vulnerable by virtue of extensive silo-hardening programme and by the imminent introduction of mobile (SS-24 and SS-25) missiles, both innovations that would complicate US retaliation plans. The development of SAM (Surface to Air Missiles) for air defence that could also engage ICBMs further threatened those plans. Furthermore, if the reports of extensive laser and particle beam research, which could have applications to, advanced weapons were true, then the erstwhile Soviets might achieve a technological 'break-out'.

Critics of Reagan's programme immediately pointed out that the plan had three minor shortcomings:

- It was technically unworkable;
- It proposed a plan violation of an existing international treaty; and
- It arguably made war even more likely.

Violation of ABM Treaty

The 1972 ABM Treaty was clearly worded to apply to large-scale strategic anti-missile systems, defined as tested against targets moving faster than two kilometres per second and above 40 kilometres in altitude. Since ICBMs move faster than two kilometres per second, and space is slightly higher up than 40 kilometres, the treaty would seem on first glance to apply. However, the Reagan White House essentially ignored the ABM Treaty, choosing a 'broad interpretation' in which the treaty simply did not apply to the new technology.

The recent withdrawal of US from the 1972 ABM Treaty, as stated by President Bush on 13 December 2001 has brought greater concern and a cause for annoyance among other nuclear weapon states (NWS). The other NWS are worried about its negative impacts and has called for strategic dialogue on the issue to avoid harming the international strategic equilibrium.

War – More Likely

The logic of Mutual Assured Destruction (MAD) is simple enough. So is its unravelling, once the balance of power is removed. Suppose an American ABM system worked even modestly well. The Soviet Union would have more reasons to threaten a first strike in any crisis, merely to maintain a credible threat. The US, in turn, would also be forced into a hair-trigger posture, increasing the risk of inadvertent war from both sides.

Preventing such obvious endless lunacy was precisely the point of the ABM Treaty. Fortunately for world peace, much Star Wars technology proved to be remarkably little more than a waste of money. Space-based lasers did not work. Particle beams did not work.

In 1993, Secretary of Defence Les Aspin renamed the Strategic Defence Initiative, now calling it Ballistic Missile Defence (BMD). But BMD still employed pretty much the exactly same people and stuff, sucking up only about $4 billion a year.

Let us study the need for change in name from SDI to BMD? 'Strategic', with its implication of great utility in the master plan of a grand war, clearly was by now an obvious misnomer: tellingly, the new name implies merely defence from individual missiles. Indeed, the new Star Wars – now conceived around ground-based missiles – is designed not to shield the US from all-out attack, but merely defend against a mere handful of missiles hypothetically launched by terrorists or what the media call 'rogue states'. There are fears that 'rogue' states such as North Korea, Iran and Iraq could develop such missiles. However, those are unfounded and possibly fear mongering.

- North Korea have been unsuccessful to develop long range missiles and has many other internal and regional issues to contend with, rather than directing any attacks at the US. They have also constructively engaged in discussions that have even seen the US lift some sanctions on North Korea. They have also halted development of their missiles since around 1998.
- It seems absurd that Iraq could even try to create such missiles, given the current weapons inspections and sanction that have decimated the country. The continuous monitoring will probably ensure that they cannot develop such weapons. They didn't even dare to use the chemical weapons it had against the US and its allies, for fear of even worse reprisal. It is, therefore, unlikely that they would use nuclear weapons. It would be a suicidal move.
- Iran also has regional worries itself. It is also moving towards a more open, democratic society.

NMD has been called 'Star Wars' because of its similarity to the failed proposal pushed by former US President Ronald Reagan. Both systems use radar and satellites to detect enemy

missiles, as they are fired, and US-based missiles or lasers in space to destroy them before they reach their targets. Two out of three NMD tests, conducted under ideal conditions, have been dismal failures. The enormous technical challenges of star wars have been likened to 'attempting to hit a bullet with a bullet'.

Under the US-Russian ABM Treaty, a US National Missile Defence (NMD) system would comprise 100 Ground-Based Interceptors (GBI) equipped with sensors and capable of over-the-horizon tracking. To protect the mainland US against a 200-warhead threat would require deployment of 7 NMD sites. Rand studies have determined that an NMD system with 400 GBIs and space sensor support can successfully engage 95 per cent of inbound missiles in a 200-warhead attack. The US DoD estimates the cost of deploying a multi-site NMD at up to $48 billion dollars over a 10-year period. The NMD baseline architecture would consist of existing early warning systems, ground-based radar, kinetic-kill ground-based interceptors and C2. France and the UK plan to deploy an SLBM force capable of carrying 384/512 warheads by year 2005.

Cost estimates for the limited NMD system currently being tested range from $60 billion to $120 billion. A full-scale missile defence 'triad' consisting sea-, space-, and ground-based interceptors – the system Bush and his Republican colleagues are advocating – could cost $240 billion or more. Even if the NMD system can be made to work on the military/technical level without breaking the budget, a hasty decision to deploy NMD poses grave risks to global stability.

Deployment could derail Russian President Vladimir Putin's offer to reduce US and Russian nuclear arsenals to 1,000 strategic warheads each, and would almost certainly provoke new nuclear weapons production by Russia and China.

Several leading powers, especially China and Russia, fear that despite the failure of the crucial flight test the National Missile Defence (NMD) system would provoke a new arms race. The NMD system, whose stated goal is to protect US territory from any limited attacks using Inter-Continental Ballistic Missiles (ICBMs), is

violative of the 1972 Anti-Ballistic Missile (ABM) Treaty.

It is now clear that the NMD system is aimed at Russia and China with Washington now withdrawing from the ABM Treaty indicates that US now wants to go ahead with the NMD programme. On December 13, 2001, President Bush announced the US withdrawal from 1972 ABM Treaty.

This statement, however, alarmed Beijing. According to Western intelligence agencies, China has around 20 missiles capable of reaching the US. Moscow, on the other hand, is apprehensive because the NMD, as conceived, can be rapidly upgraded and expanded. NMD would protect the US in case of a small or accidental launch from Russia or a deliberate or unauthorised attack from China. Many US experts admit that the threat from the so-called 'rogue states' is imaginary.

Implication for India

How will the US decision to deploy a National Missile Defence (NMD) system impact on India? Or, equivalently, what is the Indian response to such a development?

The official response has been muted and guarded. There has been no criticism, let alone outright denouncement, of the US move towards deploying the NMD. This was only to be expected given the gradual détente in the post-Pokhran Indo-US relationship. At the same time, the routine statement from the Foreign Office—that India is against the weaponisation of space, the Outer Space Treaty should be respected and arms control measures like the ABM Treaty should be preserved—will not upset its friendly relations with Russia and China, who have reacted strongly to the NMD proposal. Since the US is not a target for India's nuclear or missile force, or is it likely to be in the future, the NMD, at least in its C-I phase, is not designed for any potential threat from India. Both the Rumsfeld Commission Report of 1998 and the National Intelligence Estimate (NIE) of 1999 on 'Ballistic Missile Threat to the US through 2015' however, do take note of India's space launch vehicle and provides an option for an interim ICBM capability. Also that it is developing nuclear warheads

for missile systems and has ongoing biological and chemical weapons programmes. The latter has expressed concern over the testing of the nuclear-capable Agni II, with potential range of 2,500 km, last year.

Any change in the Chinese posture is certain to fuel a fresh round of Nuclear upgradation in Indian strategic circles. It is believed that the NMD spurred environment would heighten the threat perceptions in India and would accelerate the operationalisation and the state of readiness of the nuclear force. This could also lead to India giving up its self-imposed moratorium and renewing testing of nuclear weapons as well as delivery systems such as Agni II.

India's response could trigger a similar response from Pakistan and lead to a regional arms race. This could also mean a renewed transfer of missile technologies to Pakistan from North Korea and China. China has already indicated that US co-operation with Taiwan on TMD amounts to a violation of commitments under the Missile Technology Control Regime (MTCR). It could, therefore, retaliate by resuming missile sales to Pakistan. This could signal a revival of the occasional noises of a limited Indian anti-missile defence against the Pakistani missile force.

Placed in a scenario such as this, sandwiched between two adversaries that work in close strategic collaboration and confronted with real missile threats, if there is any country that needs an NMD, it is India. However due to lack of requisite financial resources and technological constraints, the indigenous development of NMD system would be a long time project, at least a two-three decades of concerted effort by various scientific agencies. If India accepts a BMD system from the US for its technical assistance, then apart from the technical problems, politico-strategic reasons would also stand in India's way. To have itself placed under such a system would essentially mean supporting and sustaining unipolarity. This would naturally increase in the American tendency to arbitrarily and unilaterally intervene in the Indian affairs and could seek blanket Indian endorsement for all its initiatives.

However, with the recent talk of India's Prime Minister, Shri A B Vajpayee, with Japanese counterpart during the former's visit to Tokyo in December 2001, there has been assurance of strengthening of military to military co-operation between the two countries. According to the sources, this co-operation could also include the exploration of possibilities in the Japanese ultra-modern expertise in electronics for India's ambitious satellite-based missile defence system plans. Further these sources do not rule out the possibility of the 'strategic convergence' at some time in the future leading to Indo-Japanese co-operation in the fields of optics, building sensors and robotics, crucial in the scheme of satellite based defence mission.

Therefore, it might be best for India to continue in its satellite-based missile defence system plans and to be military self-reliant, to whatever extent possible. It is already engaged in the process of building a credible minimum nuclear deterrent. This process, in the present context, must accord due importance to two factors: the Chinese response to NMD; and the impact of NMD on non-proliferation and disarmament at the global level.

The PRC's Opposition to US Missile Defence

Statements by PRC Government officials make it clear that the PRC is opposed to the development of either theatre or national missile defence system that could counter Beijing's nuclear forces. If the PRC were intent upon overwhelming these defenses, there are several options it could take in an attempt to preserve the offensive capability of its missile forces.

One of the PRC's responses could be to expand the size of its ballistic missile force, to increase the chances that some of its nuclear weapons overcome a nation's defences. This would be an expensive option requiring the PRC to invest in the production of significant additional missiles and infrastructure.

A cheaper response to US missile defences for the PRC could be the development of penetration aids (PENAIDS) for its ballistic missile. These PENAIDS could include:

- **Decoys** to create multiple radar targets. These must be tracked until the attacking missile can accomplish discrimination of the actual nuclear warhead. Simple decoys are effective during exo-atmospheric flight of the nuclear warhead, but burn up during reentry into the atmosphere.
- **Chaff** consisting of aluminium strips that are designed to reflect radar beams, thereby confusing radar as to the location of the PLA warhead; **Jammers** used to jam the radar system during the flight of the PLA nuclear warhead; **Radar** absorbing material for the nuclear warheads to absorb radar beams could be incorporated. These can also be used to reduce the radar cross-section of the PLA nuclear warhead.
- The PLA nuclear warhead itself could be reoriented to present the lowest radar cross-section. The PRC is expected to pursue one or more PENAIDs in connection with its new nuclear missiles.

Another option for countering US missile defences would be the development of a Manoeuvring Re-entry Vehicle (MARV). The manoeuvring capability could be used to complicate hit-to-kill or conventional warhead ballistic missile defence systems.

The PRC could also develop Multiple Independently-Targetable Re-entry Vehicles (MIRVs) or Multiple Re-entry Vehicle (MRV) platforms. This would effectively increase the size of the PLA's nuclear force without the full expense required to deploy additional missiles.

Chapter–IX

SPACE CAPABILITIES: AN ASIAN PERSPECTIVE

THE INDIAN EXPERIENCE: SOUTH ASIAN SCENARIO

Asian land mass includes South Asia, China, ASEAN countries, Japan, Afghanistan, Central Asian Republics (CAR), West Asia as well as the strategic Indian Ocean. The Centre of gravity of conflicts seems to be totally focused on Asia from Palestine-Israel conflict in the West to internal turmoil of East Asian countries.

There are seven countries in the space race—USA, Russia, China, Japan, France, India and Britain with another three during the last decade of 20th Century on the periphery—Indonesia, Pakistan and Australia. Notwithstanding the demise of the Soviet Union, its aerospace complex continued to pose the most significant challenge to the US security. However in 1993, US and Russia formally agreed to merge Russian Mir Space Station Programme with the Freedom Space Station Project of America, Europe, Japan and Canada. This space cooperation redefined not only relationship between US and Russia but it helped in defining the post-cold war world order more generally. This may become a defining activity of this millennium.

In the Asian scenario, Japan, China and India are established players in space. Indonesia, Malaysia, Pakistan are other interested parties. Japan's first interplanetary spacecraft started orbiting around earth and moon, gaining momentum for its 10 months, 700 million km journey to Mars. Japan has joined USA, Russia, EU and Canada for a Global Space Station which is to cost between 50 billion and 100 billion. During the recent visit of Prime Minister of India to Japan, post summit joint declaration indeed talked about the desire to further strengthen military cooperation to include 'exploration' of possibilities in the Japanese ultra modern expertise in electronics for India's ambitious satellite based missile defence systems. A strategic convergence in the scheme of satellite based defence mission shows the advance nature of Japan's space programme. Taiwan's ability to eavesdrop on China has been boosted by access to an Israeli 'Spy Satellite', EROS-1 (Earth Resource Observation Satellite), which transmits photos of one metre resolution.

PAKISTAN

Background

As regards space technology, Pakistan is way behind the other powers in Asia like China and India. However with support from the Pakistan Amateur Radio Society, National Space Agency

of Pakistan (SUPARCO) started building a small amateur radio satellite in late 1986. It was called Badr, after the Urdu language word for 'new moon'. This first satellite, Badr-1 or Badr-A, was to have been launched on the US space shuttle, but the plan changed after the 1986 Challenger explosion delayed American flights. SUPARCO's first satellite Badr-A was launched as a secondary payload into low orbit of 400–500 km; Badr-1 was inserted into an orbit of 205 km by 990 km. Intended to provide technical experience in telemetry, control, transponder and digital communications in preparation for further launches, the 150-lb satellite provided valuable data for 5 weeks. After contact with the vehicle ceased on 20 August, all efforts to restore contact with the missing satellite failed. However, during its short mission, the satellite successfully completed store/dump message tests. Badr-A carried a digital communications system patterned on the British amateur radio satellite UO-11 launched in 1984. Badr-1 offered one radio channel for digital store-and-forward communications. Uplink was near 435 MHz, downlink was near 145 MHz, and the telemetry beacon was near 145 MHz. Badr-1's orbit was so low that it reentered the Earth's atmosphere after 146 days, on 9 December 1990.

Pakistan's space programme being executed by the national space agency (SUPARCO), continues to make progress in the peaceful applications of space technology. Landsat/SPOT/NOAA

SPACE -PAKISTAN

- **SUPARCO-DR MAJID-MTCR?**
- **BIG LEAGUE JOINT SPACE VENTURE-IRAN, CHINA, SOUTH KOREA, INDONESIA, MONGOLIA.**
- **10 TOP SCIENTIST-MILITARY BADR B-C4I2**
- **American Firm(ISC) Tech-$200-330 Mn-development launcher capability**
- **Effort Build Resolution-1 Mtr**
- **Obtaining-Eye Glass, Improve Spot-obtain military disposition & PGMs.**

data products and services are being improved to meet the changing requirements of the ever-increasing number of agencies within and outside Pakistan. The station has been upgraded to cater to the more stringent requirements dictated by various applications. A number of projects in the fields of natural resources management have either been completed or are underway by using the satellite remote sensing data acquired by the Islamabad station. The development work on Pakistan's second experimental satellite Badr-B has been completed and it is awaiting in Russia the integration with the main Russian satellite for launch into 1,050 km.

Pakistan's Second Experimental Satellite Badr-B

Under SUPARCO's programme for development of indigenous capability to design, develop, fabricate and launch of low cost satellites in low earth orbit, work on Pakistan's second experimental satellite, Badr-B was initiated. The success of Badr-1 mission had given the confidence and the infrastructure developed during that mission provided a base line upon which further activities of Badr-B satellite development were based. In addition to objectives laid down for Badr-1, Badr-B had been designed to meet other useful objectives as well. Badr-B, indigenously developed by SUPARCO, was placed in a low Earth (1,000 km) sun-synchronous orbit, with a design life of over two years. Weighing about 70 kg, its mission objectives were:

- Indigenous development of low cost satellites and creation of necessary infrastructure for systems, which can be launched in space.
- Acquisition of know-how and capability in the field of guidance and control of the satellite from the ground.
- Acquisition of know-how and technology for taking pictures of earth from specialised digital camera.

It encouraged participation of the country's academic and scientific community in the peaceful uses of space telecommunication. Badr-B was launched in 1999 through the Russian Space Agency. It was to carry the following four experiments (payloads):

- Earth Imaging CCD Camera.

- Battery End-of-Charge Detector.
- Radiation Dosimeter.
- Store-and-forward Communications.

Telecommunications are vital for social and economic uplift of nations and in the promotion of international understanding through filling up or at least narrowing down of mitigation, etc. The spin off benefits of outer space must be shared in an equitable manner and for good of all. These benefits should help accelerate socio-economic uplift in the resource-deficient developing countries especially through enhanced investments by the developed countries in education, health and energy sectors.

Pakistan thinks that operational and effective BMD could make possible a nuclear first strike by a side possessing a defensive screen, which could then be used to protect the attack from the feeble retaliation of its adversary. In the view of Pakistan, an offence-defence mix would take the arms race to higher and more dangerous levels. Pakistan is concerned that new technologies developed in connection with space weapons, such as lasers and particle beams, could be applied to conventional weapons deployed by countries parties to the military alliances, amplifying the existing military asymmetries between them and the non-aligned and neutral states. Weaponisation of space could, in the view of Pakistan, also further entrench the inequitable use of outer space to the detriment of developing states. However Pakistan's case is unique as its strategic alliance with China gives adequate satellite coverage capabilities. It can be foreseen that their space collaboration with China is likely to be on the lines of the nuclear nexus, as has been proved amply.

CHINA

"By the next century, as high-tech space technology develops, the deployment of space-based weapons systems will be bound to make 'mastery of space' and 'mastery of outer space' pre-requisites for naval victory".

Shen Zhongchang
PLA Navy Senior Colonel

In 1956, advisors from the Soviet Union convinced the leadership of the People's Republic of China (PRC) to include ballistic missile development in the PRC's Twelve-Year Plan for the Development of Science and Technology (1956-1967). Having just fought a war against the United States in Korea and having come face-to-face with US military supremacy, the PRC decided that combining long-range ballistic missiles and nuclear weapons offered its best chance to build weapons capable of neutralising the United States and the Soviet Union's formidable advantage. Since that time, the PRC has embarked on an extensive ballistic missile and space programme.

From its beginning in the 1950s, the PRC has also adapted its ballistic missile programme into a major international space programme. Since its first space launch in 1971, the PRC has developed ten variations of rockets that have allowed it to place 44 satellites into orbit. Today, the PRC is embarked on a modernisation plan for its ballistic missile and space forces. This expansion includes the exploitation of space-based military reconnaissance and communications satellites and space-based weapons. In addition, the PRC has set for itself the goal of putting men in space by 2005.

Evolution of the PLA's Ballistic Missile Forces

The early development of the PLA's indigenous ballistic missile programmes was marked by Soviet assistance, and by the guidance of a Chinese citizen who had returned to the PRC after working on the US Titan Intercontinental Ballistic Missile (ICBM) programme. The PRC received its first ballistic missile in 1956, with the acquisition of two Soviet R-1 missiles. These were copies of the German cryogenic liquid-propellant V-2 missiles used in World War II. The PRC quickly acquired more advanced missiles in the form of the R-2 in 1957. The R-2 had considerable technical improvements over the R-1, including a greater range and a larger payload, as well as the use of storable liquid propellants.

In addition to the ballistic missiles themselves, the Soviet

Union provided the PRC with blueprints for the R-2 missiles, and with advisors to assist in the PRC's development of a copy of the R-2. With this Soviet technical assistance, the PRC was able to produce and deploy these missiles. In 1960, the Sino-Soviet split ended all cooperation, including missile cooperation, between the PRC and the Soviet Union. This left the PRC to continue its missile programmes on its own, using the know-how it had gained from the Soviet Union, and the expertise of its American-trained scientists.

> Qian Xuesen became instrumental in the PRC's ballistic missile programme, where he is known as the 'Father of China's Ballistic Missile Force'. A biography of Qian published in the PRC states that he 'made significant contributions to the rapid development of Chinese rockets [and] missiles, as well as space flight'.

In the field of intermediate and intercontinental missiles, China has relied on CSS series. The CSS-2 is a 1,700-1,900 mile medium range single-stage liquid-propellant ballistic missile. The PLA deploys CSS-2 ballistic missile on mobile launchers. The PRC sold several dozens of these CSS-2 missiles, armed with conventional warheads, to Saudi Arabia in 1988. The CSS-3 (PLA designation DF-4, or East Wind 4) was the PRC's first missile with 'intercontinental' range. The CSS-3 is a two-stage liquid-propellant intercontinental ballistic missile. It has a range of more than 3,400 miles, but is considered a 'limited range' ICBM because it cannot reach the United States. It uses the medium range CSS-2 as its first stage. Targets for the PLA's CSS-3 missiles could include India, Russia, the US Naval Facility at Diego Garcia and the US Air Force Base at Guam. The CSS-4 (PLA designation DF-5, or East Wind 5) is currently the PRC's main ICBM nuclear threat against the United States. The CSS-4 programme began in the 1960s. It was originally envisioned that the missile would use liquid oxygen and kerosene propellants, similar to those used

in the Soviet R-7 (SS-6) missile and in the US Atlas. In the early 1960s, however, the programme transitioned into the use of storable propellant. The PRC first attempted a flight test of the CSS-4 in the 1970s. Following several flight test failures, the PRC continued its development of the CSS-4 through its development of the Long March 2 rocket. Of the next nine Long March 2 launches from 1973 to 1978, five were successful.

During the 1990s, the PRC has deployed a total of approximately 20 CSS-4 ICBMs in silos, most of which are targeted on the United States. The Select Committee judges that despite the 1998 announcement that the PRC and the US would no longer target each other with nuclear weapons, the PRC's missiles remain targeted at the United State. Today, the CSS-4 has a range in excess of 7,400 miles. The PRC has begun deploying an improved version of the CSS-4, known as the CSS-4 Mod 2. The Mod 2 has improved range capabilities over the CSS-4. The additional range may provide the PRC with greater confidence that the missile will reach long distance targets such as Washington DC, although this and other US cities are already within the range of the CSS-4. This improved range may also translate into an improved throw-weight that could allow the PRC to deploy multiple warheads on the CSS-4 Mod 2, rather than the single warheads that are currently carried on the CSS-4.

The PLA is currently developing two road-mobile intercontinental ballistic missile systems. It also has under development a submarine launched ballistic missile. The US Select Committee judges that within 15 years, this modernisation programme could result in the deployment of a PLA intercontinental ballistic missile force consisting of up to 100 ICBMs. The first of the three new intercontinental ballistic missiles that are being developed by the PRC is the DF-31 (or East Wind 31). It is estimated that the DF-31 will be a three-stage, mobile, solid propellant ballistic missile. It will be deployed on a mobile erector-launcher. Given a successful flight programme, the DF-31 could be ready for deployment as early as 2002. The JL-2 (Julang 2, or Great Wave 2) is a submarine-launched version

of the DF-31. It is believed to have an even longer range, and will be carried on the PLA Navy's Type 094-class submarine. Sixteen JL-2 missiles will be carried on each submarine.

The PRC is also deploying, or developing for future deployment, a series of short- and medium-range ballistic missile, including both liquid- and solid-propellant technologies. Some are armed with conventional warheads and others with nuclear warheads. These missiles present a threat to US and US allies deployed in the region. The PRC's short- and medium-range ballistic missiles include the CSS-6 short-range ballistic missile, the CSS-X-7 short-range ballistic missile, and the CSS-5 medium-range ballistic missile. The PRC is also developing new versions of its short-range ballistic missiles and may produce these systems in larger quantities than earlier-generation PRC ballistic missiles. The PLA's CSS-6 (DF-15 or East Wind 15; also known as the M-9) is an advanced, solid propellant, short-range ballistic missile that uses 1990's technology. It has a range of 375 miles. It is a road-mobile missile, launched from a transporter-erector-launcher. The CSS-6 may be fitted with nuclear warheads or with an enhanced radiation weapon (neutron bomb).

An improved version, known as the CSS-5 Mod 2, is under development in the PRC. The range of these missiles, if fitted with a conventional warhead, would be sufficient to hit targets in Japan. The CSS-5 has also been developed in a submarine-launched ballistic missile version. The Western designation of this missile is CSS-NX-3; its PLA designation is JL-1 (Julang 1, or Great Wave 1). This missile is assessed to have a range of 1,200 miles. Missiles of this type will be launched from the PLA Navy Xia-class nuclear-powered ballistic missile submarine.

Following the detonation of its first nuclear weapon in 1964, the PRC publicly declared that it would never use nuclear weapons first against the homeland of a nuclear power or a non-nuclear nation. The PRC pointedly does not include Taiwan in this formulation. The PRC announced strategic doctrine is based on the concept of 'limited deterrence', which is defined as the ability to inflict unacceptable damage on an enemy in a retaliatory strike,

if required with Tactical Nuclear Weapons (TNWs) so that the escalation control capability is commandeered by PRC, as part of a security strategy.

PRC Space Programme

It was in mid-1950s that China initiated its nuclear warfare development programme. This was coupled with the search plans for space. Achievements in space commenced with the launch of China's first satellite in 1970. It launched three satellites with one rocket in 1981. It commenced geosynchronous satellite system in 1983 and by 1986 it had launched 18 satellites. The launch of DFH communication satellites series – DFH-2 in 1984–86, DFH-2A in 1988–1990, DFH-3 in 1997 and DFH-3 B in 1998–99 have contributed towards China becoming a major force in Space Programme. China plans to launch more than 30 satellites, between 2001–2005. China has so far launched 47 domestically made satellites developed under the Long March series of rockets and has developed three launch sites. US waived sanctions against China for post missile technology transfer to Pakistan and Iran, which has boosted its space programme.

China got full technical support from US, Germany and France with its first military space programme throughout since 1955. It went commercial in 1986 by capitalising on the black period in USA after the accident of Challenger series forcing USA to use Chinese launch facilities. China opened 21st Century with Shenzhou-2 spacecraft launch thus demonstrating growing capability of China's space programme. The Shenzhou-2 orbital module touched down earth. The extended mission of SZ-2 orbital module has shown that China was capable of maintaining an orbiting platform for a prolonged period. Such a capability is an important step to forward China's eventual goal of establishing its own permanent manned presence in space. China is pushing ahead with plan to put its astronauts in space and has reiterated goal, for their Space Flight, Lunar and Mars explorations. The Long March 2EA is likely to replace Long March 2E as Chinese heaviest launch vehicle. The 800 tonnes booster, measuring 50 m

in height will be capable to loft an 11.8 tonne load into LEO. It is also developing 800 tonnes/4 stage booster launch vehicle with a capacity of lofting 23 ton payload to LEO/ 11 ton into GEO.

Scan to Shenzhou - 2

The following principles govern China's space programme:

- Long-term, stable and sustainable development and making the development of space activities cater to and serve the state's comprehensive development strategy.
- Independence, self-reliance and self-renovation.
- Active promotion of international exchanges and cooperation.
- Selecting a limited number of targets and making break through in key areas according to the national situation and strength.
- A more economical and efficient development road for its space activities so as to achieve the integration of technological advance and economic rationality.
- Integrated planning, combination of long-term and short-term development, combination of spacecraft and ground equipment, and coordinated development.

The PRC has conducted research since the 1950s, including biological and life support research, on placing astronauts into orbit. Pursuant to its 921 Project, the PRC's plan since the 1980s has included concepts for Space Shuttle-like spacecraft, recoverable capsules, and a space station. In 1996, two PRC astronauts began training at the Gagarin cosmonaut Training Center, Russia. For its manned space programme, the PRC will use Soyuz capsules purchased during Yeltsin's visit to the PRC in April 1996. If the PRC is successful in placing men in orbit, it will be only the third nation, after Russia and the United States, to have done this. China announced on 10 January 2001, that it had successfully launched its second unmanned spacecraft, 'Shenzhou - 2', from the Jiuquan Satellite Launching Center, in North-west China. It was from the same centre that China launched its first long-distance

rocket carrier, on May 18, 1980; and its first unmanned spacecraft 'Shenzhou I', on November 20, 1999.

PRC Space Weapons

The PRC is believed to be developing space-based and ground-based anti-satellite laser weapons. Such weapons would be of exceptional value for the control of space and information. It is assessed that the PRC is moving towards the deployment of such weapons. Based on the significant level of PRC-Russian cooperation on weapons development, it is possible that the PRC will be able to use nuclear reactors to pump lasers with pulse energies high enough to destroy satellites. In addition, Russian cooperation could help the PRC to develop an advanced radar system using laser to track and image satellites. PRC has the technical capability to develop direct ascent anti-satellite weapons. The CSS-2 could be modified for use in this role. This would be similar to the approach taken by the Soviets with their SS-9 ASAT system.

The PRC's Future Space Launch Capabilities

The PRC also recognises the importance of space in future conflicts, for purpose that include both command and control, and military reconnaissance. The PRC is believed to be developing a new, larger rocket that will be able to carry larger payloads into orbit. PRC papers have discussed the use of cryogenic liquid propellant engines for this future rocket. One of the engines the PRC could use is the RD-120. The PRC is known to have acquired at least one of these engines from Russia during the 1990s. The RD-120 is a liquid oxygen/kerosene engine that is used on the second stage of the Zenith rocket, which is used on the multinational Sea Launch Programme. Difficulties with the development of the new engines for this rocket may have prompted the PRC to focus, in the nearer term, on the proposed Long March 2E(A) and Long March 3B(A) versions of the Long March rocket that will utilise improved strap-on boosters to achieve greater payload-to-orbit capability.

PRC's Space Development Strategy

China's Space Development in the 21st Century: A Perspective

- Build up an earth observation system for long-term stable operation.
- Set up independently operated satellite broadcasting and telecom system.
- Upgrade overall level and capacity of launch vehicles.
- Realise manned space flight.
- Build ground application systems.
- Develop space science and explore outer space.
- Nano satellite.

The PRC was drafting a space development strategy and plans oriented to the 21st Century, with the following short-term development targets (for the next decade):

- To build up an earth observation system for long-term stable operation. The meteorological satellites, resources satellites, oceanic satellites and disaster monitoring satellites can develop into an earth observation system for long-term stable operation to conduct stereoscopic observation and dynamic monitoring of the land, atmosphere, and oceanic environments of the country, the peripheral regions and even the whole globe.
- To set up an independently operated satellite broadcasting and telecommunications system. Positive support will be given to the development of commercial broadcasting and telecommunications satellites such as geostationary telecom satellites and TV live broadcasting satellites with long operating life, high reliability and large capacity, so as to form China's satellite telecom industry.
- To establish an independent satellite navigation and positioning system. This will be achieved by setting up a navigation and positioning satellite group step by step and developing a relevant application system, which will eventually bring into being China's satellite navigation and positioning industry.

- To upgrade the overall level and capacity of China's launch vehicles. This will be achieved by improving the performance and reliability of the 'Long-March' group, developing the next generation of launch vehicles with non-toxic, non-polluting, high-performance and low-cost qualities, forming a new group of launch vehicles and strengthening the capability of providing international commercial launching services.
- To realise manned space flight and establish an initially complete R&D and testing system for manned space projects.
- To establish a co-ordinated and complete national satellite remote-sensing application system by building various related ground application systems though overall planning, setting up a remote-system covering the whole country for data sharing, and forming a fairly complete application system in major application fields of satellite remote-sensing.
- To develop space science and explore outer space by developing a scientific research and technological experiment satellite group of the next generation, strengthening studies of space micro-gravity, space material science, space life science, space environment and space astronomy, and carrying out pre-study for outer space exploration centering on the exploration of the moon.

The long-term development targets (for the next 20-year or more) were laid down as follows:

- To achieve industrialisation and market viability of space technology and space applications. The exploration and utilisation of space resources shall meet a wide range of demands of economic construction, state security, science

and technology development and social progress, and contribute to the strengthening of the comprehensive national strength.

- To establish a multi-function and multi-orbit space infrastructure composed of various satellite systems and set up a satellite ground application system that harmonises spacecraft and ground equipment to form an integrated ground-space network system in full, constant and long-term operation in accordance with the overall planning of the state.
- To obtain a more important place in the world in the field of space science with more achievements and carry out explorations and studies of outer space.

PLA's Thinking on Space and Military Strategy

Roots of Chinese rationale for developing nuclear weapons can be traced back to the legacy of being occupied by foreign forces. On examination of the genesis and culture of Chinese traditional strategic thought, there is a connection to continuities traceable to Meng Zi (Mencius, 327–289 BC); Weiliao 21, a brilliant strategist of the third Century BC leading to the concept of Primacy of Man. Even Mao Zedong (Mao Tse-tung) in contemporary China said: "Man victorious over weapons." The second traditional milestone, which Chinese have always followed is the 'Primacy of Defence' typified monumentally by the great wall.[1] All these traditional thoughts reflect the Chinese nuclear strategy and the evolving space strategy as a part of its national security strategy. It is only of late, that it appears to be coming out of this posture to a more proactive stance. Negativism and Minimalism are yet another set of governing principles. Negativism is the art of manipulation of all disadvantages so as to active the summation of positive. Even Gunzi (720–645 BC) said: "The ideal is to fight no war; the second best is to fight only once." Spelling out all the above strategic thoughts positively link with the existing nuclear weapons strategy of China, which is linked to its developing space capability.

China's status as a land power, its bitter experience of foreign intervention, and its traditional self-image of being at the centre of the universe dictate that the Chinese defence establishment would focus on physical survival and national autonomy.[2] The Chinese have always viewed the United States with great suspicion starting with its support for Chiang Kai-Shek and the Nationalists as is articulated below—

> Asserting the military situation, Mao asserted that Chiang's rule was doomed unless the United States rescued him. He then warned of the possibility that "the United States would send armed forces to occupy some of China's coastal cities and directly fight against us" and that it "might throw in its own forces to blockade China's ports".[3]

Nuclear and Space Strategy

China's delineation of security strategy in the new millennium is to develop such a power base that it never again suffers the degradation's it experienced between the first Opium war and the Communist victory over the Kuomintang in 1949 as the time when China lost control of it's own destiny to the imperial powers of Britain, Japan, France, Germany, Russia and the United States.[4] This colonialism has dictated China's psyche to have a strategic view that enshrines freedom from fear of domination by hostile powers as the core of national security strategy.[5] To implement this strategy is to have a military capability both conventional, nuclear and space, which will prevent coercive diplomacy and hegemony. Hence China's space and nuclear strategy has never been explicit but ambiguous. As Sun Tzu has famously said: "The essence of warfare is but the art of ambiguity." In its operationalisation, China has the following five objectives for their space and nuclear strategy.

- Secure superpower status and enhance and absorb RMA including space in its future force structures.
- Preclude the possibility of intrusive diplomacy through nuclear coercion.

- Deter other nuclear regimes (such as the breakaway states from the former Soviet Union).
- Retain a trump card for the eventuality that Japan may rescind her current pacifist policies for a military option and;
- Maintain political and moral ascendancy over its regional rivals (such as India).[6]

The small number of nuclear weapons and limited space weapons capability in the Chinese military limit their ability to have a full spectrum counter-force strategy. Consequently, the Chinese have adopted a strategy of minimum deterrence. Paul Godwin and John J. Schulz in their article in Arms Controls Today point out that:

China's overall deterrence strategy is designed to preclude nuclear blackmail. The idea is to create a countervalue (city-busting) deterrent of sufficient size and range to guarantee that no enemy planner could use nuclear force, or threaten to use it, without the certain knowledge of Chinese retaliation at a level sufficient to make the costs too high.[7] For this strategy to be pragmatic, China would have to enhance space military capabilities in conjunction with its nuclear arsenal and philosophy.

China is establishing one of the most daunting conventional theatre missile challenges in the world, which the PLA views as an asymmetrical trump card against superior force. These conventional missiles, supported by space based reconnaissance and combined with a pre-emptive strategy, provide Beijing with a keen psychological tool and possible military advantage, particularly in the Taiwan Strait. China's theatre conventional missiles and space reconnaissance architecture are emerging as the cornerstone of Chinese war fighting strategy.

PLA's thinking on Space on Military Strategy could be summarised as under.

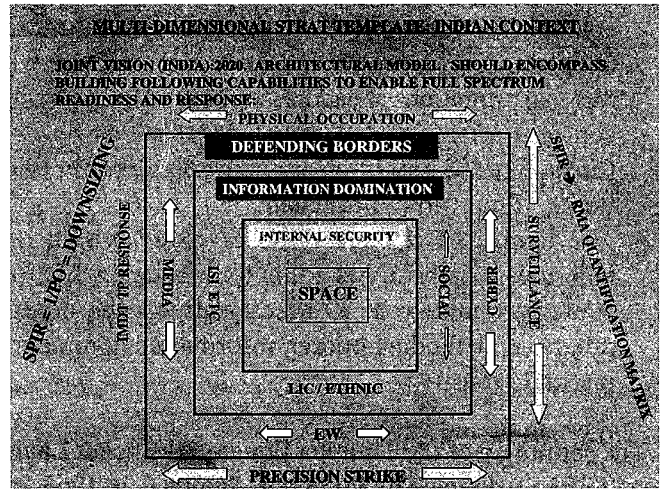
- Adherence to active defence and modern peoples war.
- Defence policy in new era to include defending 'Sovereignty' and 'Ocean Rights' and safeguarding 'National Security'.

- Considering that China's missile development programme was coupled with the search plans for space from early 1950s, China's missile and space development are complementary to each other.

THE INDIAN EXPERIENCE

"India has already stepped into Space and shown its relevance. I believe 21st Century is going to be the century for planetary exploration. There is going to be a deep outreach into the cosmos. Many countries would subsequently be thinking of colonising these celestial bodies."

K Kasturirangan
Chairman, ISRO



Multi-Dimensional Strategic Template: Indian Context

Security of nations is a dynamic interplay of defending borders, information domination, internal security and space. Joint vision 2020 should encompass building following capabilities to enable full spectrum readiness and response—

- Defending borders with physical occupation, fully

integrated and supported with surveillance devices to gain early warning. The capability to have such a force structure, which can immediately respond to any intrusion; precision strikes forming an important pillar for such a response. The balance between effective surveillance and overall force for physical occupation being inversely proportional i.e. high technology surveillance could result in substantial reduction of alertness level as well as requirement of troops.

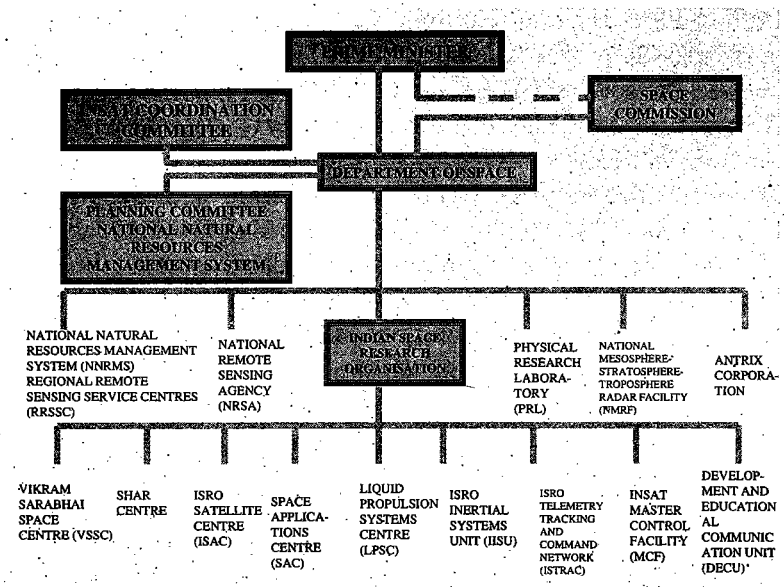
- The second matrix of the template envisages Information Domination which involves all forms of media management, early warning means to include electromagnetic spectrum and information technology means including cyber media.
- The Internal Security of a multi-ethnic, multi-cultural country like India plays a dominant role in the strategic template. It involves a balanced social structure wherein regional aspirations are addressed politically. Low intensity conflicts arising out of imbalances fuelled by external forces like ISI activities are controlled within tolerable limits, if not fully eliminated.
- The centre of the template is space which if used judiciously and fully is going to infuse new life into the strategic template as it directly affects the other three pillars i.e. defending border, information domination and internal security.

The setting up of the Thumba Equatorial Rocket Launching Station (TERLS), directed by Vikram A. Sarabhai, in 1963, marked the beginning of the Indian Space Programme. The Government of India established the Space Commission and the Department of Space (DoS) in 1972 to promote unified development and application of space science and technology for identified national objectives.

In 1963, PRL played the historic role in initiating the formation of the Indian Space Research Organisation (ISRO) which

was later to become the instrument for the development of India's space programme with Dr. Vikram Sarabhai, who was then the Director of PRL, becoming its chief supporter, so much so, that till 1972, all the funds to ISRO were flowing through PRL. The pioneering scientific payloads that were fabricated by PRL scientists and flown aboard the first rockets that were fired from the then TERLS, provided valuable experience to design and develop more complicated rocket and satellite experiments, which were of significant national importance.

The organisation of Department of Space (DoS), which has ISRO as its important organ, is as under—



The Indian Space Research Organisation (ISRO) is the research and development wing of DoS and is responsible for the execution of the national space programme. ISRO also provides support to universities and other academic institutions in the country for research and development projects relevant to the country's space programme. Both the DoS and ISRO headquarters are located at Bangalore. The development activities are carried

out at the centres and units spread all over the country. In order to promote a rapid development of activities connected with the space science, space technology and space applications, the Government of India considers it necessary to set up an organisation, free from all non-essential restrictions or needlessly inelastic rules, which will have responsibility in the entire field of science and technology of outer space and their applications.

DoS implements the policies framed by the Space Commission. Research and development activities are carried out through the ISRO, the NRSA, the PRL and NMRF and Antrix Corporation. India's first satellite was orbited by the USSR in 1975 and the first domestic space launch was conducted in 1980. In May 1982, US imposed trade sanctions against ISRO, based on its missile proliferation activities. The main centres of DoS include Sensors and Payloads Satellite Application Centre at Ahmedabad; Design Development Assembly (ISAC) at Bangalore; Launch Vehicle (VSSC) and Liquid Propulsion Modules at Thiruvananthapuram; Satellite Launching at Sriharikota, Master Control Facility at Hasan and Remote Sensing at Ahmedabad.

The Indian Space Programme is directed towards the goal of self-reliant use of space technology for national development. Its main thrusts include satellite communications for various applications, satellite remote sensing for resources survey and management, environmental monitoring and meteorological services and development and operationalisation of indigenous satellite and launch vehicles for providing these space services.

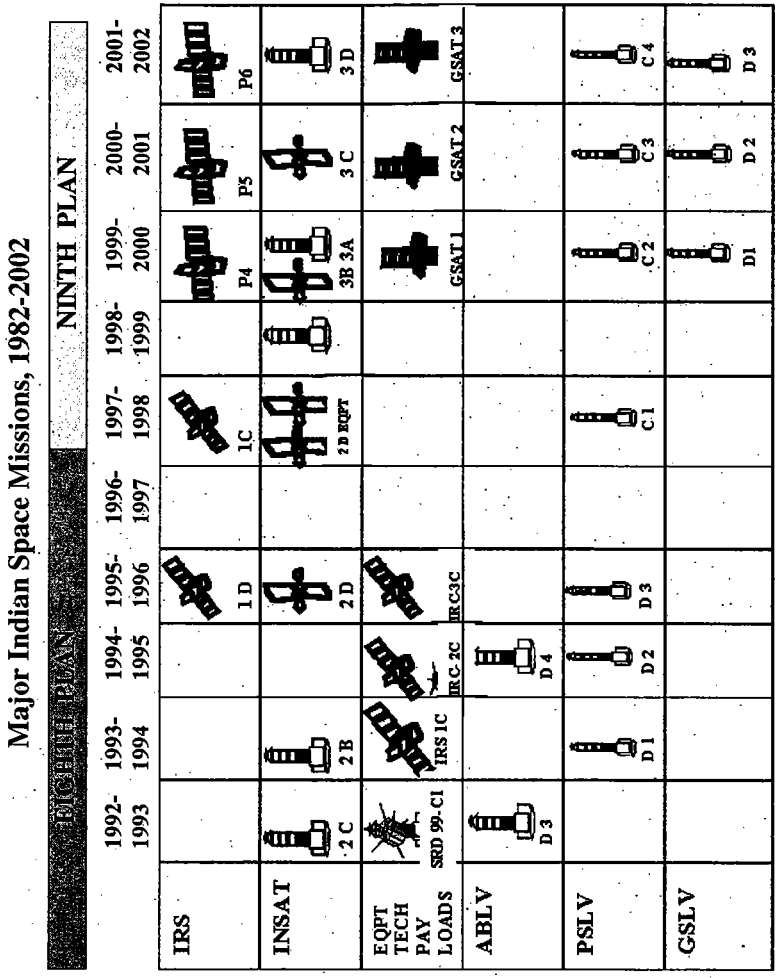
The picture-perfect launch of the GSLV D-1 in April 2001 opened a whole new chapter in the Indian space programme. Once they become operational, GSLV would hoist INSAT satellites into geosynchronous orbits 36,000 km above the equator. In this position, the satellite keeps pace with the earth's rotation and appears stationary from the ground. So antennas on the ground do not have to track moving satellites. The INSAT system is one of the largest domestic communication satellite systems in the world and it has vastly improved telecommunications, television broadcasting, and radio networking, meteorology and disaster

management services in the subcontinent. India's jaded credentials as a big country with poorly developed ground infrastructure facilities was burnished only in 1998 with the launch of the INSAT-2E, the first in the series of long-life mission satellites.

Indian Space Programme

- The Geosynchronous Satellite Launch Vehicle (GSLV) has been chosen for all launches. INSAT-2A and 2B were launched in July 1992 and July 1993, IRS-P2 in 1994, while December 1995 saw INSAT-2C and IRS-1C being put in space, followed by IRS-P3 in 1996. These have enhanced business communications, increased TV outreach (well beyond India's boundaries) and now there is greater coverage and accuracy to meet data collection.
- The Ninth plan period (1997–2002) will see the launch of INSAT-2D, 2E, 3A, 3B, 3C, 3D (also 3E as a ground space satellite); IRS-1D, P4 (Oceansat-1), IRS-P5 (Cartosat-1), IRS-P6 – with the polar satellite launch, will also make totally indigenous launches possible from INSAT-3C onwards. The Cyber 2000 computer makes for a more efficient forecasting network. INSAT-2E, the last of the second generation satellites in INSAT series, was launched in April 1999; INSAT-3B, the first of the third generation satellites, proceeded INSAT-3A.

The GSLV's significance lies in the fact that the future of the global satellite market lies in the field of communications. The first experimental payload aboard the GSLV-D1 is the GSAT-1, which was put in a geo-synchronous orbit. It has three C-band transponders, and two S-band transponders to help in digital audio broadcasting and other communications. Liberalisation of Internet services will now increase the demand manifold for satellite communications from service providers who would want high-speed data links quickly. Consequently, the demand for transponders which cater to VSAT – a system that uses small rooftop satellite dishes to receive and send radio signals networks would also go up.



Crucial Cryogenic

Now that the spotlight is on the top-end GSLV, much depends on the indigenously developed Cryogenic Upper Stage Project (CUSP), as it is expected to be the mainstay of future GSLV flights. India's cryogenic motor development went through some rough weather in 1993 when exaggerated US concerns that India might utilise its space capabilities for military purposes led to Moscow backing out of a deal on cryogenic engine technology transfer to New Delhi. In hindsight, it seems to have been a disguised blessing as it prompted ISRO scientists to develop the technology on their own. The GSLV's maiden flight may have been made with a Russian cryo-stage, but with the CUSP scheduled for completion soon, India would still be only the sixth nation to possess this cutting edge technology, joining the US, Russia, France, Japan and China. The country has had just four failures in 15 launches which is above the average performance when compared to countries like China and Japan that are still struggling on the learning curve of the launch business.

The GSLV demonstrated the capability to propel a 1.5-ton payload to a precise spot 35,587 km into space. Dr. Abdul Kalam, who based his confidence on the 'experience of over 50 successful space and defence rocket launches', was open about the synergy between the satellite launch and defence programmes. The GSLV is designed to put a satellite into its spatial orbit, and burn itself off in the process. Alter its inertial navigation system to change trajectory and flight path for reentry into the earth's atmosphere, and the GSLV becomes an ICBM, with a weapon payload instead of a satellite, capable of hitting any place on the planet.

An ICBM would require improved metallurgy to prevent burnout of the payload upon reentry into the atmosphere, and a terminal guidance system comprising cutting edge technology to withstand buffeting by winds and ensure accuracy in hitting the target. India has tested this technology – which incorporates infrared sensors and television images of the target – successfully in the shorter-version Agni-II.

The Mission to the Moon

The US and the European Space Agency are planning major expeditions to the moon and intend to setting up a station, just like in Antarctica. ISRO estimates that up to 2010, international co-operation would increase towards the moon. In a bid to emerge as a global space power, India plans an ambitious lunar launch that will boost its technological capability and ignite popular imagination. It is likely to cost Rs 350 cr for launch in orbit, which will mean increase by 5 per cent in ISRO budget. In 1998, Lunar Prospector made an interesting discovery of presence of water-ice in the moon's craters. This may allow colonisation of moon in due time.

In India, the Moon Mission[8] has its propagators as well as critics. The Moon Mission has ignited fierce debate in scientific circles. The critics basically point out to lost interest by US and erstwhile USSR after early 1970s and only in 1990s did interest resurface with the Japanese sending its Hiten Orbiter followed by US built Clementine. Some doubt the technical benefits accruing from such a venture and want ISRO to focus on specialisation

The Moon Mission

To go	Not to go
• Demonstrate that India is on the cutting edge of technology.	• India needs the money spent to build more and superior satellites.
• Renewed interest in the moon's potential – need to get a foothold quickly.	• Moon's surface thoroughly explored. Nothing new we can contribute to it.
• It will reinvigorate ISRO which has reached the limit of its current vision.	• Plenty of gaps in utilization of space data. Fill these first.
• It will boost India's overall technological capability in cyber systems.	• Better to develop commercial competency in niche areas like low-cost launches.

in low cost access to space by providing cheapest launches. Notwithstanding criticisms, the comparatively low cost of launch i.e. 350 cr could be undertaken from the saving of budget which would not only revive the spirit of exploration and providing spin off technologies but also ensure an early foothold, should moon play a dominating role as a space station.

With India's space programme reaching a plateau in terms of technological development, the mission to the moon is designed not only to boost the country's international standing but also to re-energize scientists to reach for greater heights. Given the costs, however, the lunar effort may initially be confined to an orbiter around the moon equipped with sophisticated equipment to carry out scientific experiments. Even for this, India would have to considerably step up its rocketry and guidance capabilities.

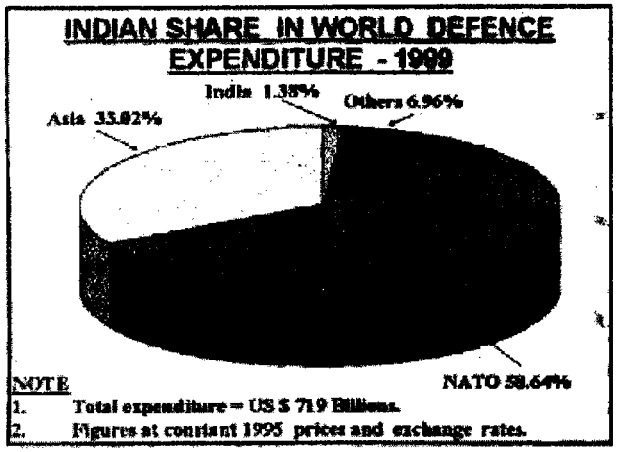
The country does not as yet have powerful rockets to launch a lunar module weighing a minimum of 2 tonne to such a distance. Apart from that, work would have to be done to make the module livable by reducing the noise and vibration levels. More importantly, India would have to set up a centre to train astronauts to withstand the tremendous strain in space. All these would jack up costs considerably putting it out of reach for the country's space researchers. For ISRO, the moon mission comes at a time when, having fulfilled some of its basic objectives like building and launching satellites, it is now setting its sights on new challenges.

India—Ready to Move into Inter Orbit

With the launch of GSLV in 2001, three stage vehicle capable of boosting 2.5 tonne spacecraft into GTO was launched in 2001. Cartosat –1 (earth-imaging satellite) in 2000. India plans to launch a 4-staged, 294 tonne PSLV on a lunar mission by 2008. It will be capable of propelling 250 kg satellite into fly-by mission to the moon or placing 130 kg satellite into lunar orbit. India is already emerging as a bulwark of global and Asian stability. Therefore, its role in South Asia is unquestionable. By its combined Military Space Technology, India would be able to curtain the

regional conflicts including domination of the Indian Ocean, which is a conduit of oil power in the future. Thus the creation of a joint space military infrastructure now would definitely enable regional power projection at least by 2015–2020.

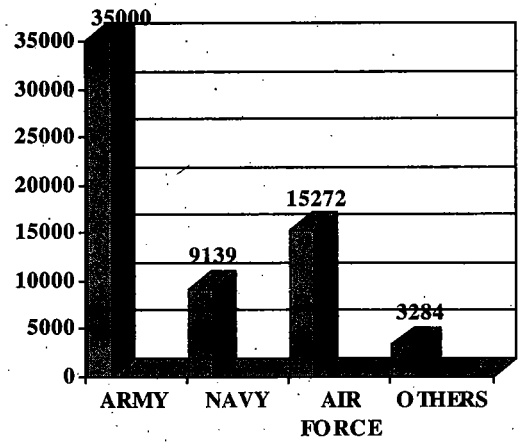
Budget Analysis



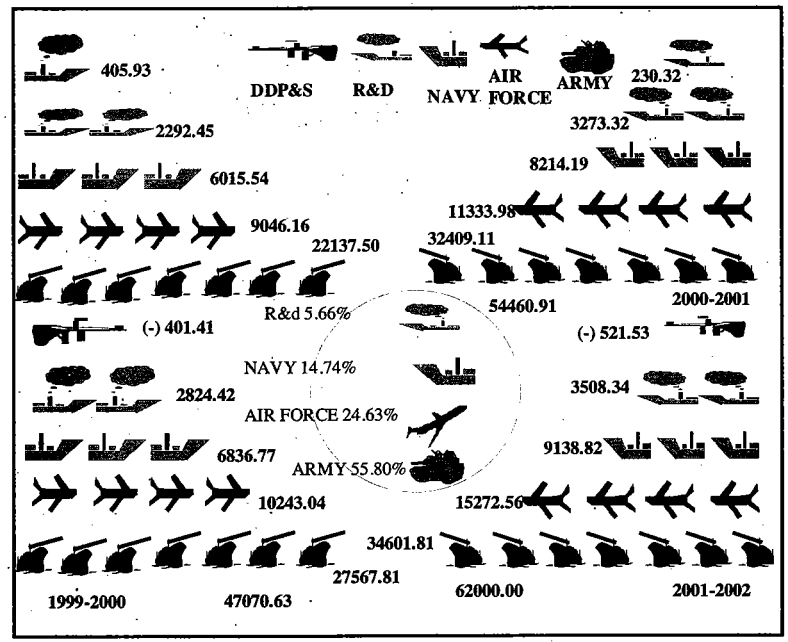
SERVICE WISE BREAK UP OF BUDGET ANALYSIS: 2001-2

- **Grand Total – 13,0181 cr**
- **Communication – 20,434 cr**
- **I&B - 811 cr**
- **IT - 535 cr**
- **S&T - 947 cr**
- **DAE - 2,068 cr**
- **Dept of Space - 1,710 cr**
- **Moon Mission - 350 cr**
- APOLLO 11-1969 $25 bn (11,250 cr)
- MULTINATION SPACE STATION-100 bn (45,000 cr)
- US - 100 bn (45,000 cr) Lesser than current Indian Defence budget
- CHINA - ?
- PAK - ?

Legand: I&B = Information and Broadcasting; IT = Information Technology; S&T = Science & Technology; DAE = Department of Atomic Energy.



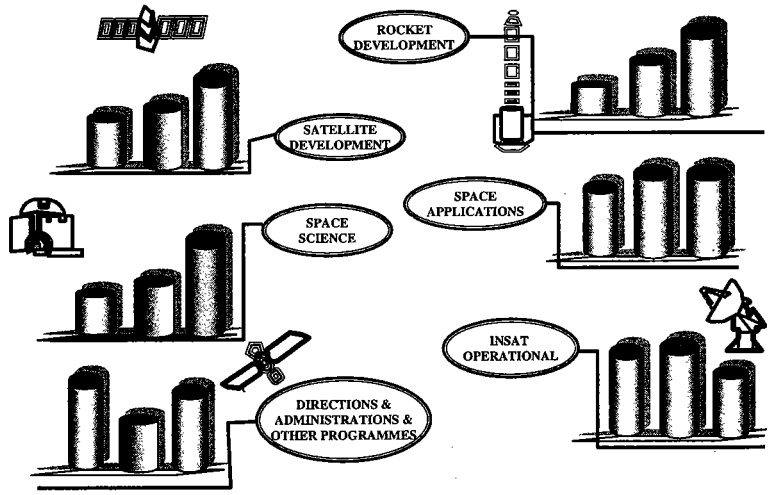
SERVICE WISE BREAK UP OF DEFENCE EXPENDITURE



The budgetary allocation as shown in the diagram from 1998–99 to 2001–2 to various departments of the Services highlight that the overall budget for the Service has increased from 39,898 cr to 62,000 cr over the last three years, of which manpower intensive Army gets about 55.30 per cent. Notwithstanding that, there has been an increase jump in allocation of budget for Air Force. The budget for Research and Development at 5.66 per cent is very low compared to other countries. If 2 per cent of the services budget for 2001–2 is saved i.e. Rs 1,240 cr and is spent on defence satellite, it will result in launch of one satellite per year. Marginal cuts all around will result into exponentially greater pay-offs in terms of availability of reconnaissance and command and control means.

Area wise distribution of funds below highlights that rocket development has overtaken INSAT operational as far as fund allotment is concerned, and hence, it continues to be the focus of attention. The funds for rocket development have marginally increased by approx. 17,517 lakh over the revised estimates of

AREA WISE DISTRIBUTION OF FUNDS



the previous year and is higher than increase of 15,940 lakhs for satellite development. Space application and Space science continue to get low budget support (16,180 and 6,134 lakhs respectively).

Planning of Budget

Indian share in world defence expenditure at 1.38 per cent is very low compared to its size. The Department of Space at 1,710 cr needs enhancement of budgetary allocation. Budget as well as objectives shape military space postures. A few long lived, state-of-the-art space systems may seem cost-effective in short term but in war timely procurement of highly costly equipment may prove difficult. A cost-effective mix of modern high technology weapon systems with older, time tested equipment might produce desired results in developing countries like India.

LOW COST OPTION

- 40 × DIVISIONS (DIV).
- ONE DIV – Cost of Raising 1,100 cr + Recurring cost – 201 cr × 10 = 3200 cr.
- Armed Div 5,468 + 3,980 = 9,448 cr.
- Grand Total = 11,648 cr
- LEO – 200 – 400 Crores
- GEO – 1,500 Crores
- MOON – 350 Crores
- $ 400 Per day – $ 100 per day

Space Forces vs Conventional Forces: Need for Balance (Low Cost Option)

A cost-effective analysis of building satellite capabilities *vis-à-vis* developing conventional military capability in India's scenario needs to be carried out as a small research project so as to come to definitive figures. The involvement of the three Services and ISRO would become necessary in such a cost analysis. However, by probability and perceptions, the calculations could be on the following lines. India has about 40 Infantry Divisions and three strike corps for India's defence management on both

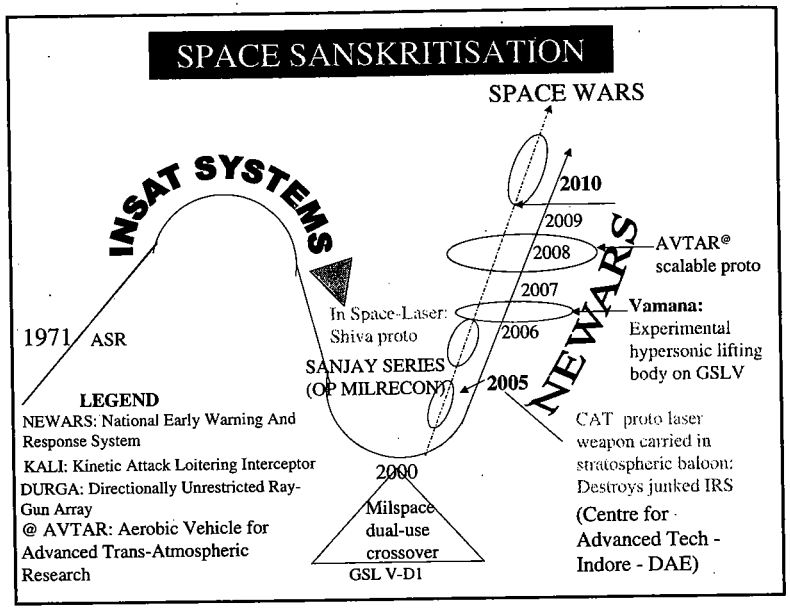
the borders. Satellite Surveillance, PGMs (directed through satellites), Low Earth Orbit (LEO), laser platforms and navigational capabilities should allow, approximately one-third reduction of physical deployment (presently, about 25 divisions are deployed on borders). This should release at least six to eight divisions i.e. strength of 1,20,000 to 1,50,000 personnel, thus cutting down defence revenue expenditure, (equivalent to 1,200 to 1,500 cr approximately). Thus saving can be recycled towards satellite development (costing between Rs 200 to 400 cr each). Thus, the physical role of troops can be performed by just a few satellites and also a cost saving of 600–800 cr. In fact, in future the cost of maintenance of troops would only increase and that of launching/ maintaining satellites would decrease due to cost-effective technologies. A similar matrix can be drawn for the Air Force and Navy. The Air Force would get the desired 'AWACS' capability automatically, other than guidance and navigation during deep penetration/interdiction strikes. As regards the Navy, the fast building up of China's presence in the Indian Ocean would be negated by space domination over the Indian Ocean ranging from the Gulf to the Straits of Malacca without recourse to heavy patrolling duties. Further, in due time, various space related conventions are likely to fall in place akin to the Maritime Zones, giving exclusive rights of space to nations under them. In totality, therefore, space militarisation for self-defence, even in a regional context, would become the new formula and *mantra* for military capabilities and stability in South Asia. In fact, a space war-game matrix model be developed by 'WARDEC' with the aim of assessing efficacy and reductions that can be caused in conventional troop levels. This would be true modernisation.

Therefore, India's announcement of reaching the moon by 2005 has to be seen against the backdrop of technological breakthroughs and collaborations of other countries including China and Pakistan. It becomes imperative for India to create a military blueprint for the next twenty years to face the challenges in these 'New Frontiers'. A 'Space Cell' should be created in respective Service Headquarters, as the nodal agency for interface with the

military. These cells could also be tasked to evolve futuristic doctrines that could be tested, experimented and validated for a future scenario. This would obviously match the requirements of the 21st Century, when India emerges as one of the global powers.

Future Naval Warfare

Certain cutting-edge technologies are likely to be applied first to Naval Warfare. Direct attacks on naval battlefields will become possible from outer space, high altitudes and remote land bases because 'naval battle space is going to expand unprecedented'. New technologies in nuclear propulsion, space, shipbuilding, microelectronics, satellites, air cushion effects and surface effects will be 'material base of the new military revolution' which will also influence naval combat doctrine and operational concepts. Submarines will make missile attacks on air targets. They will rise in status to become a major naval warfare force. Anti-submarine warfare will restrict submarines in shallow water-zones. There is no doubt that during the revolution, combat theory and concepts will be largely modified. Concentration of ships will be replaced by small formations and single vessels. Vessels will be distributed 'evenly' in the sea. Underwater strikes will be another important combat mode for the Navy. The role of submarines in future information warfare will be very important. The opponent's information network will be an important target. There will be digitization of sea warfare to connect platforms and all arms of the Services. Long-range precision strikes by warships, carrier-based aircraft, and missiles. The seabed will be an ideal place to build military bases to include water aircraft carriers and undersea mine-laying robots. Tactical laser weapons will be used first in anti-ship missile defence systems. Laser, particle beams and microwave beams will have precision and lethality. Naval ships and cruise missiles will become stealth capable. Long range combat, missile combat, and Air Force cover will be crucial. Over-the-horizon strikes will be key to future battles. Speed against speed will become the crux of future naval victory. Naval battles will be mostly of medium and small scale.



(Source: USI April – June 2000)

Lightning attacks and powerful first strikes will be more widely used. There will be no grand scenes of decisive fleet engagements. The future naval warfare force organisation will grow ever smaller and more multifunctional.

Indian Objective.

In the established International Varna Order (IVO),[9] the West must not only close ranks to survive but must maintain military superiority which means maintaining the gap in capabilities between them and their adversaries. From mid-60s to the announcement of SDI, military satellites averaged 100 launches per year (70 per cent of total). This has major lessons for India.

A definite need for India to have military satellite and have a proactive role in reducing the gap with West (IVO concept) and at the same time enlarge with our adversaries through policies which enhance our capabilities i.e. increased research and development and acquisition of advanced technologies and those which retard adversaries' progress.

India has successfully 'leveraged' denial regimes of space and missile programmes even during post Pokhran sanctions. It should be able to carry forward at faster pace in the changed strategic environment due to post September 11 events.

India's military doctrine should therefore aim at 'Space Superiority' in the short term and 'Space Control' in the long term against its adversaries. This will involve India becoming geo-military co-occupant of space – the hegemon's last remaining high-ground – until the militarisation of space is ended. That defines the concept of Space Sanskritization given above in the form of road map up to 2010.

Force Structuring in India's Case

- Vision-2020
- Downsizing
- Space cell, Techno-Generals
- Full spectrum integration of space assets
- Jointness
- Integrated information nodes
- Mobility
- Dominating manoeuvre doctrine

Vision 2020.

The key to defence adequacy is flexibility and responsiveness, not the capacity to carry out a fixed blueprint. Global stance that

VISION 2020

• Up to 2005: Milrecon, OP Sanjay series	• MIL STRATEGY.
• Up to 2010: Kali, Durga, Avtar	• Full force integration
• Up to 2020: Commencement of Space war, lunar landing in alliance...	→ • Navigation, weather, Met, Missile warfare, S&R & Communication integrated with C^4I^2.
	→ • Partnership Alliances
	• Build Core Military
	→ • Competency

must be supported by ample military power, a coherent but readily changeable defence strategy and a flexible force posture.
To achieve 'Vision 2020'—

> "Creation of an integrated IT force, synergized by system integration, architectured by innovative doctrinal attributes, supported by responsive cost-effective organised structures and validated by a cycle of experiments and formulation, for mission accomplishment against the physical dimension of four front, non-tangible dimension of cyber and space wars in a nuclear and mission proliferating environment where space technology and info highway are fast becoming the new military high ground, against the backdrop of coercive disarmament diplomacy."

Downsizing.

With the launch of military satellites, and high technology surveillance means, requirement of troops for border management can reduce by 25 per cent. Expenditure on launch of satellites is correspondingly decreasing while the maintenance costs of troops is ever increasing. Absorbing high technology for fighting low intensity conflicts by synergization of information domination, improved mobility, command and control and accuracy of weapon systems is going to be cost effective.

Space Command/Cells, Techno-Generals.

There could either be space cell for each service integrated through CDS or have a Space Command on the lines of US Space Command, to support joint employment of military space related forces and to ensure improved operational support to other unified commands. This command could assure mission responsibility in the fields of Space Operations, Surveillance and Warning and Ballistic Missile Defence Planning. Integration of staff including highly specialized civilian scientists with technology savvy generals is essential. This structure will consequently result in full spectrum integration of space assets, Jointness, Integrated Information Nodes and Dominating manoeuvre doctrine.

Integration.

Integration of the ground soldier duly aided with GPS, laser range finder and responsive means of communication with fire support means in the form of UAV guided PGMs should be the basis of working for 'Mission Oriented Teams'.

Military Strategy up to 2020

2000–2005

Gyrsmositation and synergization involve joint and combined operations, integrating the services through CDS, Joint Chiefs of Staff Committee and having unified and specified commands like Port Blair command.

Force Structure Modifications/Increments. Space Cells, Space Defence Centre, Information Nodes and DIPAC to be integrated to the organisational structure. Co-ordinate their activities through CDS.

Consolidate the gains in areas where we have technological edge i.e. Information Technology, remote sensing, missile and satellite technology. Launch military satellite by marginal cuts on services budget (2 per cent), consequently, enhance surveillance capability. This is likely to reduce troops for border management.

Technology domination through increased research and development and acquisition of advanced technologies. Enhance ranges of PGMs for larger and accurate engagement.

Develop 'Military Doctrine of Space Dominance' by extending war and its power into Space and the Planets. Sanskritization of space as given out earlier.

Priority to enhancement of air power, notwithstanding the turf war. Increase space budget to at least four folds from the existing 2,000 cr (approximately).

Carry out intelligence networking through satellites to ensure quick information gathering and flow of information to commanders at various levels.

2005–2010

Increase investments in space programme. Investment in

space will result in cost-effective defence. If S is Space Force, and C is the Combat Power (Army, Navy and Air Force). Then double in Space Force (2S) is going to have an exponential increase in Combat Power (C^2) keeping A, N and AF constant.

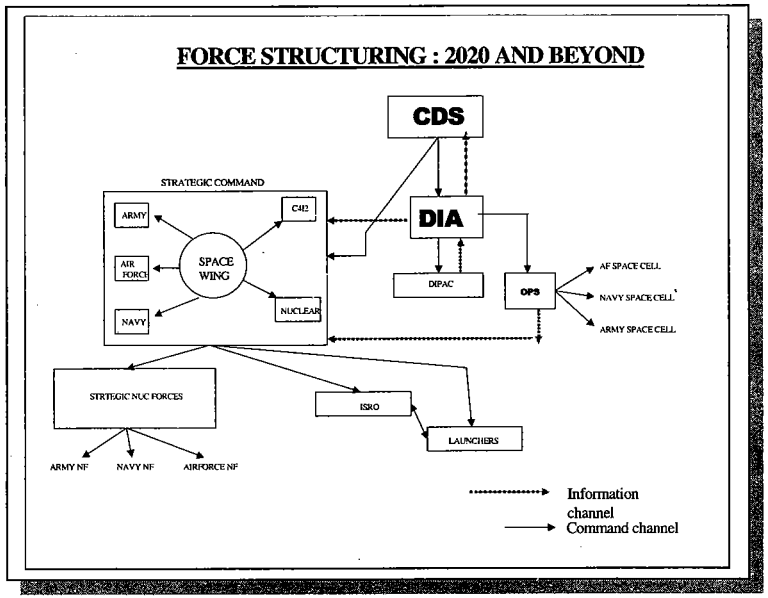
Enhance the scope of space application in $C^4 I^2$ to make the system more responsive with in-built expansion facility. Cater for satellite redundancy to ensure 24 hours uninterrupted coverage. Plan for induction of PGMs, DEW and laser weapons systems.

2010–2020

Shift in military strategy wherein Centre of Gravity shifts to space assets. Space Control/Space Superiority by ensuring access to space while denying the same to potential adversary. Sanskritization of space in a phased manner which includes induction of hyper planes/shuttle. Develop and test a nuclear-space doctrine.

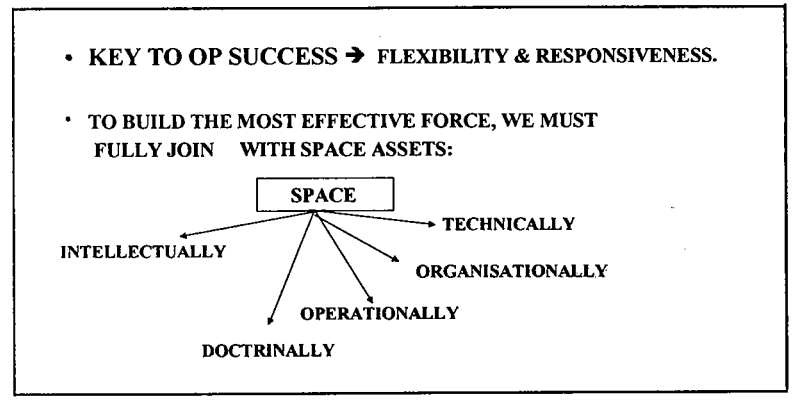
2020 and Beyond

Force structure 2020 and beyond will envisage CDS structure



fully integrated with space wings of various services and 'Information' forming an essential base. Strategic nuclear force, ISRO and research and development are the other important organs.

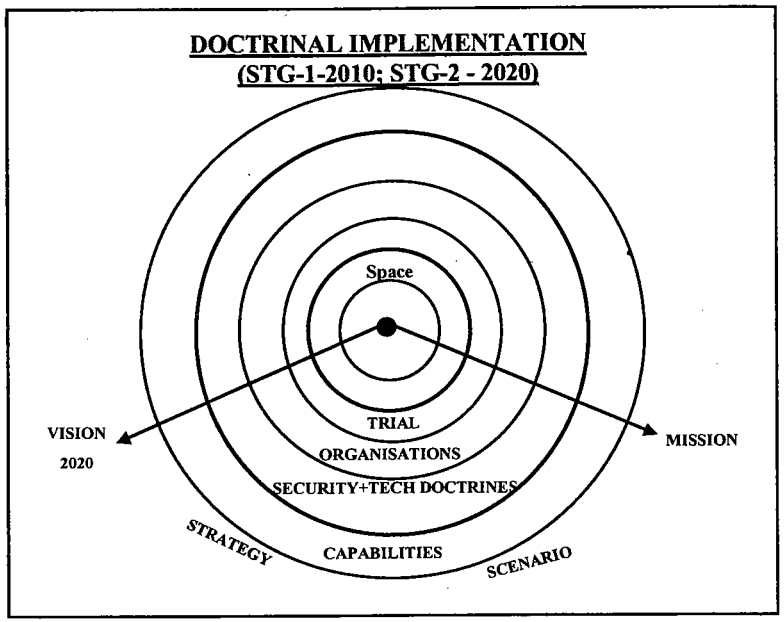
Key to Op Success



In the changed context where space and space forces are going to play a dominant role, the combined and all arms concepts will require intellectual superiority to draw out doctrines and theories, technological advancement to induct and assimilate the latest systems, organisational restructuring to make the system responsive and flexible, development of operational art to work in the changed scenario. The key to operational success being flexibility and responsiveness. Information technology will be a main pillar for such responsiveness.

Doctrinal Implementation

There is a requirement to understand the strategic scenario which will exist in 2020 for which vision 2020 has to take into consideration the changing environment and technological development. From this vision, own national interests will dictate the mission. To fulfil the mission, capabilities will have to be developed including research as well as transfer of high technology which will contribute towards shaping the architecture of global power. Security and technology doctrines will emerge, based on



combination of nuclear-military-economic power criteria. Organisational changes and absorption of equipment including trials will be necessitated. Industry and technopreneurs will play a major role towards technology development and assimilation. At the centre of all this would be Space.

CONCLUDING ANALYSIS

Concepts and Doctrines

The evolvement of concepts and doctrine should be carried out to cover short term (2000–2010), medium term (2010–2020) and long term (beyond 2020) scenarios. This will ensure mid-course corrections necessitated due to changes in technological, security and strategic environment. Accordingly, all arms concept and combined arms concepts will have to be worked out, tried and refined.

Force Sizing

Qualitative superiority in technology has major implications for priority of defence requirements. The present concept of mass may have to be replaced by smaller number of combat units, with a proper mix of high technology warfare systems. In the developing countries such as India, the time lag in absorption of technology will require a fine balance with downsizing.

Army.

Revolution in military strategy has to take into consideration extension of battle space in all spheres including space, possibility of simultaneity on front and rear axis, new meaning to time and space and induction of high technology precision warfare systems. The developing countries like India are manpower intensive and low in technology. As is evident from recent Afghanistan war, space technology with high technology ground forces can achieve decisive victories in shorter duration, totally negating the aspects of terrain, size and mass of a country. Accordingly the following model for Army is suggested—

- A smaller force with the ground soldier having the latest information and firepower support systems, which are totally integrated with digitalized information network.
- Every unit including support system will be in contact with enemy force on the battlefield as there will be no front line.
- C^4I^2 system will require integration at all levels. Dedicated military satellites would be necessary.
- The downsizing of Army and absorption of technology has to be in consonance with each other. Accordingly the following options exists—
  - Post September 11 events have focused world attention on terrorism. Funding against global terrorism will open avenues for strategic partnerships for India. Redundancy of terrorism concepts with international repercussions on terrorists organisations may see a resurgent India overcoming internal disturbances. This

should help India in reducing the conventional forces i.e. Rashtriya Rifles getting demobilized or being handed over to Ministry of Home Affairs (MHA). The savings accruing to Army would be effectively utilised for modernisation and absorption of high technology.

- In second scenario, should terrorism continue to dodge the country, the reduction of force would be possible only once high technology has been absorbed for fighting low intensity conflict which include surveillance devices, high technology precision guided weapon systems for surgical strikes as well as responsive Command and Control structure. Inclusion of air arm especially the attack helicopter force for surgical strikes would be extremely necessary.
- Budget analysis would suggest a mere reduction of 2 per cent budget which would amount to saving of 1,240 cr, which could be used for the launching of military satellites. Consequent, troop reduction in border defence by 25 per cent can be expected.

Navy.

Indian Ocean is dominating the sea space between ASEAN countries to the African coast. Central Asian Republic (CAR) states being energy cauldron of future, as well as the presence of a large number of nuclear and missile force of superpowers specially in the context of Afghanistan conflict adds more importance to Indian Ocean. Presently Indian Naval fleet is a pittance considering the expansion of Chinese Navy to cater for domination of Malacca Strait in South China sea as well as its enhanced role in Indian Ocean. India has to evolve security doctrine for Indian Ocean to include the quantum of naval vessels as well as induction of high technology space systems and ensuring continuous surveillance, feedback and quick response. This would be a more cost-effective strategy.

- In any naval threat from East or West, the key issue would be integration of space assets with naval forces including

those of submarines. There has to be an entirely fresh look on the intermix between space assets and naval forces.

- Electromagnetic combat superiority will dictate a dedicated set of satellites for Indian Ocean. Accordingly Naval C^4I^2 system will be the nerve centre and force multiplier of naval warfare.
- A substantial submarine force will need to be developed and integrated with the space forces.
- It will be evident from Budget Analysis 2001–2 that there is a requirement to double the present budget of the Navy at 9,139 cr as well as enhance contribution towards development of these assets and force structure for integration with space capabilities.

Air Force.

The air battlefield will become decisively significant in future warfare due to growing significance of space as well as technology development. Accordingly, the air assets and air strategy needs to be reworked on the following lines—

- Air Force to control space assets.
- The tactical air assets to be handed over to Army and Navy which will constitute their dedicated air arms.
- Air Force to deal with strategic air assets as well as its integration with space assets. The proposed Space Command to have a dominant role for Air Force.
- The present budge of Air Force at 15,272 cr needs an upward revision to cater for high technology including stealth technology and its integration with space assets.
- Work on a strategy to develop Aero-Space Force in 2015 scenario and a Space Force beyond 2020 AD.

Combined Forces.

Combined Operations will be the main process of combat. Future wars cannot be carried out by single adjustment/increments in the structure of services. The new structure will be a network formed by land, sea, air and space forces. CDS structure will

need to be broad based and include the defence procurement, production and research and development. Accordingly research and development could be handed over to services which could be under CDS. The responsive nature of such a system is likely to remain time bound and cost bound. Close integration with ISRO, DAE and industry will have to be worked out. Dedicated research for high technology weapons is pre-requisite to satisfy defence strategy.

Technology and Doctrine Pushing

The operational concept of jointness, shorter duration of wars involving deep attacks on all fronts employing own C^4I^2 systems and degrading adversaries will be supported by high technology stand-off, precision guided weapon systems. This 'technology pushing' will lead to 'doctrine pushing' which will basically be all arms and joint operations. Such operations will encompass combined land, sea, air, space as well as domination of electromagnetic spectrum. This may result into the following concepts—

- Long range combat in the form of long range strikes with missile and air force, followed by rapid deployment of troops transported by land, see and air.
- Outer space combat will envisage an enhanced role for outer space and result in effective use of latest precision guided weapon systems, stealth technology and RPVs. Setting up of space station, their protection and destruction of those of potential adversary will result in shift of focus to outer space.

Financial Planning

The present defence budget at 62,000 cr has 34,305 cr (55.3 per cent) for Army, 9,139 cr (14.8 per cent) for Navy and 15,272 cr (24.6 per cent) for Air Force. This is roughly 2.7 per cent of GDP. A marginal increase of 0.5 per cent of GDP will result in additional 10,000 cr. This could be re-proportionated to various services to include research and development, launch of satellite

and organisational restructuring to cater for combined forces concept. Such an amount over next five years will necessarily result into technological development and savings due to consequent reduction in forces, which could be reinvested for modernisation and technology development.

Information Warfare

Information warfare is likely to control the form and future of war. A totally integrated Information System involving all services will be essential. Information networks of all branches will have to merge to form a single combat network. This information war will necessitate India having the following structure—

- Dedicated military satellites which include three for Indian Ocean and two each for Western and Northern borders. All other commercial satellites to have dual use facility for military purposes.
- Collection of data, its interpretation and dissemination necessitates an effective co-ordinated cells duly integrated at CDS and Chief of Staff Committee levels.
- Establishment of a strategic reconnaissance, warning and air defence system.
- The budget for such a surveillance grid could be by affecting marginal cut on defence budget or raising of additional funds.

Alliances

Recent events in Afghanistan suggest a broad consensus on terrorism resulting in alliances. This has opened a window of opportunity for India to naturally align with forces bent upon elimination of terrorism. This strategic alliance could be used to procure, absorb and update the ever-changing technology. In India's case such an alliance needs to be generalized on a long term basis as part of a nation's defence strategy. Needless to say that the days of non-alignment are over.

The events of last decade or so have reinforced the importance

of 'Electromagnetic Spectrum' and 'Space'. Integration of these five dimensions was witnessed during Gulf war and has been reinforced with the recent happenings in Anti-terrorism war of Afghanistan. It has been an endeavour to highlight the asymmetry existing in our strategy and vision which resulted into Kargil misadventure by our adversary. An effort has been made to focus towards technology development with resultant change in concept, doctrines and organisational structures. The ethos of 21st Century, even in developing countries such as India has to be on 'Combined and All Arms Concept', totally integrated with 'Space Superiority' or even 'Space Domination'. This may seem a bit far-fetched. But that vision duly supported by reorientation of thrusts including reduction of conventional forces seems achievable.

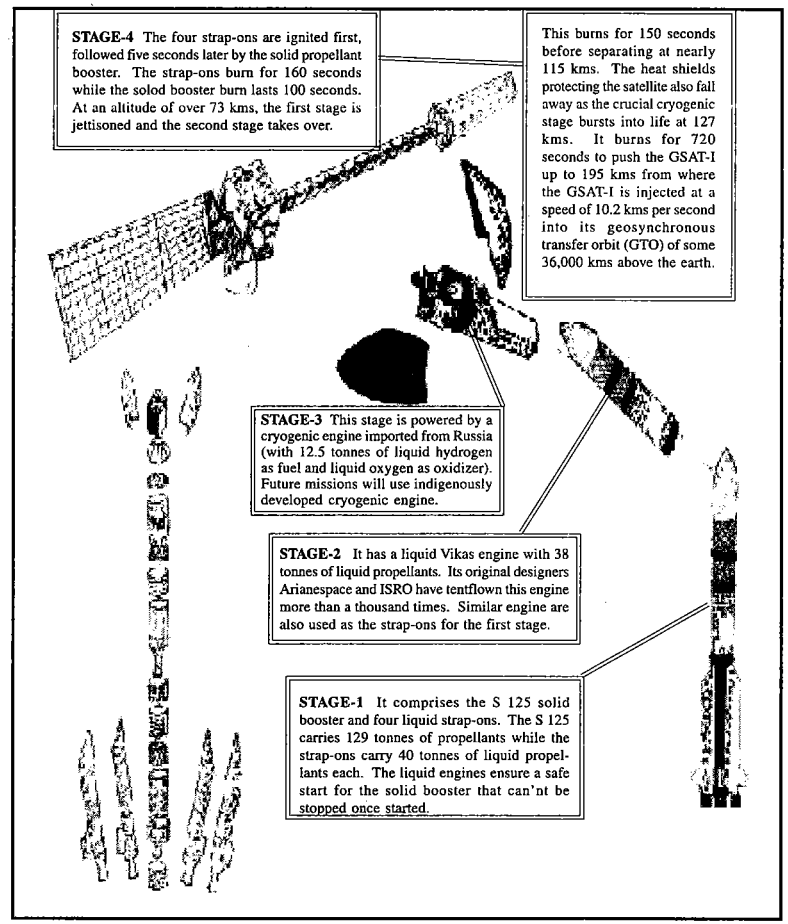
A PHILOSOPHICAL POSER?

HIDER vs SEEKER

- BFT – directly proportional to:
  - INVISIBILITY
    - Optical → Smoke/ Dummy
    - EMS → Stealth
  - Survival of Tanks?
- Militarisation - Small Drones – Tgt – infantry

In the future wars of 21st Century it is the game of 'Hider' versus 'Seeker'. Battlefield Transparency (BFT) with all the modern gadgets is going to be directly proportional to invincibility and survival will depend on efficacy of methods employed by both the seeker and the hider. Can we get an answer to this dichotomy on philosophy from our valued readers. All battles

of the future will be hinged on the contest between the 'Hider' and the 'Seeker'. Space capability will be giving this cutting edge.



Appendix A

AGREEMENT BETWEEN PAKISTAN AND INDIA ON PREVENTION OF AIRSPACE VIOLATION

Aware that despite best efforts by both sides, violations of each other's airspace have occurred from time to time.

Desirous of promoting good neighbourly relations between the two countries. Conscious of the fact that renewed efforts should be made to avoid unnecessary alarm.

Have agreed to enter into the following Air Agreement.

Air Violations

Article 1

Henceforth, both sides will take adequate measures to ensure that air violations of each other's airspace do not take place. However, if any inadvertent violation does take place, the incident will be promptly investigated and the Headquarters (HQ) of the other Air Force informed of the results without delay, through diplomatic channels.

Article 2

Subject to Articles 3, 4 and 6, the following restrictions are to be observed by military aircraft of both the forces.

- Combat aircraft (to include fighter, bomber, reconnaissance, jet military trainer and armed helicopter aircraft) will not fly within 10 kms of each other's airspace including ADIZ. No aircraft of any side will enter the airspace over the territorial waters of the other country, except by prior permission.
- Unarmed transport and logistics aircraft including unarmed helicopters, and Air Observation Post (AOP) aircraft, will be permitted up to 1,000 meters from each other's airspace including ADIZ.

Aerial Survey, Supply Dropping, Mercy and Rescue Missions

Article 3

In the event of a country having to undertake flights less than 1,000 metres from the other's airspace including ADIZ, for purposes such as aerial survey, supply dropping for mercy missions and aerial rescue missions, the country concerned will give the following information in advance to their own Air Advisors for notification to the Air HQ of the other country.

- Type of aircraft/helicopter.
- Height of flight within Plus/Minus 1,000 ft.
- Block number of days (normally not to exceed seven days) when flights are proposed to be undertaken.
- Proposed timing of flight, where possible.
- Area involved (in latitude and longitude).

No formal clearance would be required as the flights are being undertaken within own territory.

Air Exercises Near Border

Article 4

In order to avoid any tension being created, prior notice be given with regard to air exercises, or any special air activity proposed to be undertaken close to each other's airspace including ADIZ, even though the limits as laid down in Article 2 are not likely to be infringed.

Communication Between PAF and TAF

Article 5

In matters of safety and any air operations in emergency situations, the authorities designated by the respective Governments should contact each other by the quickest means of communications available. The Air Advisor shall be kept informed of such contacts. Matters of flight safety and urgent air operations should promptly be brought to the notice of the other side through the authorities designated by using the telephone line established between the Army Headquarters of the two countries.

Operations From Air Fields Close to the Borders

Article 6

Combat aircraft operating from the air bases specified below will maintain a distance of 5 km from each other's airspace:

- Indian Side
  - Jammu
  - Pathankot
  - Amritsar
  - Suratgarh
- Pakistan Side
  - Pasrur
  - Lahore
  - Vehari
  - Rahim Yar Khan

Flights of Military Aircraft Through Each Other's Airspace

Article 7

Military aircraft may fly through each other's airspace with the prior permission of the other country and subject to conditions specified in Appendix A to this Agreement.

Notwithstanding paragraph 1 of this Article, each country has the sovereign right to specify further conditions, at short notice, for flights of military aircraft through its airspace.

Validity of Agreement

Article 8

This Agreement supersedes all previous understandings in so far as airspace violations and over flights and landings by military aircrafts are concerned.

Article 9

This Agreement is subject to ratification. It shall come into force with effect from the date on which the Instruments of Ratification are exchanged.

Appendix B

SPACE WARFARE: FAQs

Fundamentals of Space and its Astronomy

- Space is termed to denote the entire universe i.e. the earth and its atmosphere, the moon, the sun and the other solar systems over the infinite skies.
- Although no life has been proved on Mars but there is a possibility of some water and organic compounds on Phobous and Deimus, the two satellites of Mars. Obviously, Mars has a space base potential.
- The moon is earth's satellite. The total travel time to the moon from the earth at the speed of 1,000 kmph would be 19 days 20 hrs and 9.6 second. The moon's period of rotation is equal to the period of revolution about the earth i.e. 27.32 days. Thus the moon qualifies to be the space base; the stepping stone for future military activities in space. Countries would deploy strategic forces on it. Occupation of moon would be decisive at least in a global war.
- Voyager-II, a project of NASA, has already toured outer planets covering more than 7.2 billion kilometres. This project has discovered 19 new moons, till date. It is hoped that it sets into, what is called the interstellar medium i.e. the gas that is between the stars. The future, therefore, lies in interstellar travels within and outside our solar systems. Voyager-II proves this point. Probably in the first quarter of next century Voyager type missions may be manned.

Satellites in Space

Reconnaissance satellites.

These are used for arms control verification and for achieving

battlefield transparency.

- Photographic Reconnaissance satellite includes TV cameras, multispectral scanners and microwave radars, to detect pinpoint targets.
- **Electronic Reconnaissance satellites** carry equipment designed to detect and monitor radio signals generated by the potential adversaries' military activities. These satellites also gather data on missile testing, new radar's and many other types of communication traffic.
- **Communication satellites** are used as reliable and secure communication systems for transmission of large amount of data received from space based and land based surveillance systems. These satellites are also used by command & control elements of armed forces of various countries. Even communication between mobile forces is being conducted via satellites. These satellites are classified as Geo-synchronous, Semi-synchronous and orbital.
- **Navigation satellites** carries out Doppler analysis of signals emanating from radiating space based radio beacons, which helps in navigation and global positioning. Even weapon trajectories can be monitored and countered suitably. US is planning such satellites for defecting nuclear explosions in the atmosphere and in outer space.
- **Ocean Surveillance and Oceanographic satellites** are used in knowing what is happening in the ocean, which can help in designing the anti-submarine sensors, and can improve the accuracies of missiles launched from ships/submarines.
- **Scientific Research & Meteorological satellites** are used in metrological data, extra-atmospheric astronomy, space biology and space medicines.
- **Geodetic satellites** are used to study the physical nature of the earth and then assists in mapping the earth. Satellite laser ranging and radar altimetry have helped in ascertaining the pattern of earth's gravitational potential.

Anti Satellite Weapons (ASW)

- The conventional weapons are based on missiles and satellite technologies, whereas unconventional weapons are those which use directed electromagnetic radiation as a means of destroying or damaging a satellite.
- A LASER beam can damage the target (satellite) essentially in two ways. For energies between 10^6 &10^4 W/Cm^2 the incident continuous LASER beam melts or evaporates the solid surface. At higher energies (>10^9 W/Cm^2) and with shorter pulse lengths, not only does the target surface vaporize but it is also ionized, producing a high density plasma which continues to absorb the incident LASER radiation. The extreme temperature increase at the surface causes the LASER produced plasma to blow off or vaporize towards the LASER beam. This, in turn, generates a hydrodynamic shock wave rupturing the target (i.e. satellite).
- In a chemical LASER, the inverted distribution of excited molecular energy states is obtained by means of chemical reactions. Most commonly used chemical reaction is between hydrogen and fluorine and between deuterium and fluorine, emitting radiation at a wavelength of 2.7 nm and 3.8 nm respectively.
- The Triad programme consists of three elements, code named Alpha, LODE (Large Optical Demonstration Experiment) and the space borne Talon Gold.
- Four more advanced LASER concepts are also being investigated i.e. excited dimmer and excimer LASER, the free-electron LASER, the gamma-ray LASER or Graser and the X-ray LASER.
- The second concept pertains to Electromagnetic (EM) guns and could be regarded as a hybrid between conventional weapons and more futuristic Direct Energy weapons (DEWs). An EM gun simply hurls a projectile by using EM forces. The main advantage is the momentum and higher projectile velocities.

- The third concept, the electromagnetic pulse weapon is based on the possibility of producing a directed EMP effect. Nuclear weapons exploding in outer space could devastate the opponents satellite and disrupt or even destroy electronic components of communications networks and computers. However, since the EMP weapon with directional property has not yet been devised, it would affect the attacker's satellites. This problem is likely to be overcome in the future by a process of nuclear hardening of satellites.

Anti Satellite Capability (ASAT)

- Weaponisation of space is already on although the 'Outer Space Treaty of 1967' prohibits the same.
- Most of the ASAT weapons tested up to 1980 fell short of the range in reaching military satellite.
- Both nuclear and non-nuclear ASAT weapons held by USA and Russia would definitely be of longer range.
- Approximately, a total of 20 ASAT tests were carried out by the then Soviet Union between October 1968 and June 1982.

Space Based Defensive System

- The first concept of space-based BMD (Ballistic Missile Defence) System is the use of high energy LASERs orbiting the space.
- The second concept is the use of satellite-based missile interceptors. In this concept 432 satellites, each armed with 40–45 missile interceptors, would be placed permanently in orbit around the earth. The interceptors, each capable of obtaining a velocity of about 1 km/sec relative to the carrier satellite, would be guided by Infrared sensors to home in on energy missile boosters and destroy them by colliding against them at high speed. However, this system by itself is very vulnerable.
- The third BMD concept which is under trial by US is partly space-based. This system would consist of several

hundred LASERs each operating at or near the visible light spectrum. The LASERs would be interspersed throughout the US land mass and would be fired at large earth-orbiting mirrors launched in great numbers on warning of an attack by enemy missiles. The LASER light would be reflected off and refocused by these mirrors onto targets.

- The fourth BMD concept could operate in neutralising an ICBM during the reentry phase. The idea being to unbalance the heat shield to ensure burning off of the missile before it enters the earth's atmosphere. This can be even done by a non-nuclear area EMP explosion along a carrier dictated and identified by ballistics.

Militarisation of Space

The present outer space treaty prohibits weaponisation, hence, the military aspects of existing satellite functions would increasingly encompass the following as our dependence on satellites—

- Command, control, communication, computer and Intelligence & Information ($C^4 I^2$).
- Metrology & Remote Sensing.
- Early Warning & Electronic Intelligence (EW & ELINT).
- Navigational Global Position.

Satellites: Utilisation in Disarmament and Arms Control

SALT & ABM treaties have been monitored through satellites, which form primarily the National Technical Means (NTM).

Star Wars

- Star wars would be fought in space with the ultimate aim of victory on ground.
- Star wars would take three distinct phases—

The Satellite Phase

- This would involve shooting out each other's satellites

with a view to gain superiority and freedom of action thereafter.

- This would involve firing of LASERs or ammunition of tremendous velocity at long ranges from 100 to even 10,000 kilometres.
- The future would also lie in creating reflective shields on satellites against LASER weapons or even designing of Anti-Satellite weapons (ASWs).

The Destruction Phase

This would involve destruction of the population, communication and other strategic installations on the earth by various means such as space weapons, nuclear strike, burning of opponent's satellite, satellite LASERs etc.

The Mopping Up Phase

This would involve physical taking over of the territory and capture of the army, installations and population with a view to harness the resources of that country for self-perpetuation and advancement.

- An Anti Anti-Satellite Weapon (AASW) is to be placed in conjunction with Anti Satellite Weapon (ASW) for providing mutual support to each other (i.e. Killer Satellites). US has already tested the firing of an ASW.
- Resume satellites of all types are to be kept ready on the ground for a launch if required. They would replace the destroyed satellites.
- Employment of minor tactics, such a twin astronauts as a team with space scooters would have to be trained for commando type of raids on enemy satellites.
- Once the star war starts, it will be a battle for domination of space, which would depend on the numerical superiority of satellites at a given point of time.

Impact on Command and Force Structure

- The impact of advancing space technology will affect

the command responsibilities and Inter-Service force re-structuring.

- Delineation of Inter-Service command should match the future battlefield requirements and the threat perceptions against potential adversaries.
- The various options discussed for delineation of Inter-Service command are—

  Option 1—Air Force be given an 'Expanded Role' and should form the Air Force command headquarters where both the Army and space resources get integrated to the Air Force.

  Option 2—Army be given enhanced inter-connectivity and Inter-operability contained with real time data accessibility, flexibility, autonomy and centralisation of function are achieved by integrating the tactical Air Force and missile systems with nuclear delivery capability.

  Option 3—Space command be added as a fourth service to the existing three services.

- The best option to be decided would vary for nations. In the case of Asian region where nations have vast land frontiers, option 2 is recommended.

Emerging Technologies

- The emerging battlefield milieu would be 'IT' intensive which would integrate the functions of individual weapon systems at various strata in the atmosphere from artillery guns to precision guided missiles, Unarmed Aerial Vehicle (UAV) aircrafts, various surveillances and weapons platforms in outer space into one cohesive force by automated command and control.
- Certain weapon technologies that are likely to emerge are—

  Control weapons (particle beam/chemical LASER).
  UHF weapons.
  Ultrasonic waves weapons.

Stealth weapons.
Mirror beam weapons.
Plasma weapons.
Ecological weapons.
Smart weapons.
Logic weapons.
Sonic weapons.
Electromagnetic rail gun.

- The launch of the first Sputnik in 1957 had started a star war when more than 5000 objectives which included 200 to 300 operating satellites are being constantly tracked by radars in space.
- USA established a civilian led NASA to avoid its inter-service rivalries in the projected arms race, that provided them with R&D facilities.
- The period of 1960s saw the space arms race between the two superpowers i.e. USA and the erstwhile Soviet Union, reach its pinnacle.
- Testing of nuclear weapons was fractured by the Partial Test Ban Treaty (PTBT) of summer 1963, followed by UN Outer Space Treaty of 1967, Declaration of legal Principles, governing the use of outer space.
- In USA, Air Force space command war formed in 1982, a Naval space command in 1983 and an Army space command in 1988.
- Few more countries (including China and India) are progressing fast in space technology.
- ABM Treaty of 1972 was evolved to curb an arms race.
- The Gulf war of 1991 signified as the First Space War in history.
- America's first satellite was placed into orbit by the Army's Jupiter C rocket, January 3, 1958.

Ballistic Missile Defence (BMD) Systems

- The ABM Treaty, as amended by the protocol of 1974

limits the deployment of ABM systems to 100 fixed land-based launchers, interceptors and radar systems for the defence of one particular area facilitating defence of an ICBM base. However, none of the countries have diluted the sanctity of deter once.

- The relevance of BMD systems, therefore, is more oriented towards territorial defence rather than celestial objects.
- The main controversy on space-related BMD is that they may unbalance the nuclear defence and upset the global paradigm of power. Therefore, BMD or even SDI cannot be really categorized as a defensive system and will remain more offensive in nature.
- The Russian view of deployment of BMD system is clearly offensive as it will enable the capability to launch a first strike with impunity as this system would degrade retaliation by the responder. The Russian nuclear philosophy has been 'No First Use'.
- The Chinese nuclear philosophy has also been of 'No First Use'.
- In India's context, it's the parallelism to above views, should be the principle.

Lasers

- UK Royal Navy used LASER Dazzler in 1982 Falkland war and that PLA has learnt to deploy such a weapon.
- ZM 87 LASER interference device causes temporary blindness (up to 10 kms). PLA's Type 98/WZ-123 MBT carries turret mounted installation, a medium powered LASER to make an optical/electro-optical sensors void.
- US Joint NLWD studying pulsed chemical LASER that produces 'Plasma Ball' as target surface, causing stress waves and destroying internal components.
- US in its space programmes is going to deploy space base LASER and large Aircraft IR counter measures (LAIRCM).
- US hopes to deploy fleet of 7 x Boeing 747-400F that

can engage ballistic missiles in boost phase, from stand off ranges of more than 400 kms.

- Satellite Borne LASERs are possible long term plans as successor of ABL.

  It will involve a constellation of 20–40 satellite at an altitude of 700–1300 kms.

  The system would engage any missile (range >120 km) during its boost phase and doesn't require prior knowledge of launch site.

  Each satellite would carry acquisition, tracking and pointing system using low power target of more than 3,000 kms, be able to engage at least 100 targets. For e.g. the Alpha programme confirmed in 1991 that high energy chemical LASER could generate sufficient power to destroy a missile.

- An Atomic Bromine LASER, OP at 2.714 microns has potential of being directly pumped by sunlight without expanding fuel. The LASER is currently under investigation at AF Philips Lab.
- Space Based LASERs in output power 1 to 5 milliwatt range can burn retina.
- LASERs emitting more than 1400 nm are 'Eye Safe'

International Coop in Space and India

- One of the recent cooperative effect is modular upto Electronic Scanner (MOS) instrument from German Aerospace Centre on board Indian Remote Sensing Satl (IRS-P3) along with ISRO's Wide Field Sensor (WIFS). Data from this is being analysed not only by German and Indians but also in USA and Europe.
- French National space Agency (CNES) working for joint satellite mission called 'Megha Tropiques' that aims to study atmosphere and climate. The satellite will be launched on PSLV in 2005.
- PSLV also being considered by others for cooperation

and commercial arrangement for launch of small and medium class of satellite into different orbits.

- DoS has signed MoU for cooperation in space with Australia, UK, US, Canada, China, Europe Space Agency, France, Germany, Hungary, Russia, Sweden, Peru, Netherland, Ukraine, Brunei, Israel, Indonesia, Italy, Mauritius and Norway.
- DoS is playing active role in international bodies such as UN Committee on Peaceful Uses of Outer Space (UN COPUOS), UN Economic and Social Commission for Asia and Pacific, Committee on Geostationary Met Satl, The Global observation strategy.
- DoS is having a scheme of Sharing of Experience in Space (SHARES).

Views and Declarations

India

The first Indian Satellite, ARYABHATTA was launched in 1975.

India has an abiding interest in the protection of civilian satellites and in keeping space free of weapons.

As per Indian estimate, 75% of the satellites now in space are performing a variety of military roles, which are designed to enhance the effectiveness of the use of nuclear and other weapons on the earth.

India explores the development of anti-satellite weapons and is in favour of multilateral negotiations for banning them.

India is concerned also over aspect of current research into space weapons that may be applied sooner or later and into conventional weapons with disastrous consequences for the future of international peace and security.

Pakistan

Pakistan thinks that operational and effective BMD could make possible a nuclear first strike by a side possessing a defensive

screen, which could then be used to protect the attack from the feeble retaliation of its adversary.

In its view, an offensive-defence mix would take the arms race to higher and more dangerous levels.

Pakistan is concerned that new technologies developed in connection with space weapons could be applied to conventional weapons deployed by countries parties to the military alliances, amplifying the existing military asymmetries between them and the non-aligned and neutral states.

China

According to China the development of space weapon could not only further aggravate and escalate the arms race, but also create greater instability and increase the danger of war.

In the view of China—

- The militarisation of inter space involves not only space weapons but also the satellite systems established for military purpose.
- Outer space should be used exclusively for peaceful purpose.
- It's primary objective would be to prevent an arms race in outer space.
- The de-weaponisation of space would only be a first step on the way to the "non-militarisation of outer space."

The Delhi and Mexico declaration

The Delhi Declaration (January 2, 1985) on outer space states that it must be used for the benefit of mankind as a whole, not as a battleground of the future.

The Mexico Declaration (August 7, 1986), urged the erstwhile Soviet Union and USA to agree on a halt to further tests of ASAT weapons, in order to facilitate the conclusion of an international treaty on their prohibition.

Legal Aspects: Outer Space

* *Charter of the UNs.*

The first instrument to be taken into consideration on an outer space is the charter of the United Nations (1945). The application and interpretation of the provisions raise a number of unresolved problems. They concern the following—

It's principles, in particular Article 2, i.e. all members shall retain in their international relations from the threat or use of force against the territorial integrity or political independence of any state, or in any other manner inconsistent with the purposes of the UNs.

The guarantees of security of states, as given in Article 5, i.e. nothing in the present charter shall impair the inherent right of individual or collective self-defence, if any armed attack occurs against a member of the UN, until the security council has taken measures to maintain international peace security.

* *The Partial Test Ban Treaty.*

The treaty banning nuclear weapon tests in the atmosphere, in outer space and under water, signed on August 5, 1963, constitutes one of the first examples of a new approach to disarmament.

* *Outer Space Treaty.*

The treaty on principles governing the activities of states in the exploration and use of outer space, including the moon and other celestial bodies, signed on January 27, 1967, has been formulated with the framework of the UNs, still constitutes the main basis of law applicable to outer space.

Aerospace Power in 21st Century

Revolutions

With the emergence of a revolution of great scientific, technological, military and social significance there is going to

be the emergence of 'Aerospace Power' in the 21st Century.

The last quarter of the 20th Century has seen rapid developments in area such as computers, PGMs (Precision Guided Munitions), satellites, IT (Information Technology), and the vast virtual world of software programming. These developments have introduced revolutionary concepts in weapon design, air and space platforms, and the mean to exploit information through networking. This combination of air and space power or aerospace power, inevitably in the 21st Century will become the most critical element of national power.

Aerospace technologies are the fusion of developments in aviation, space, computers and communication. Technological evolution has led to the integration of computers and communications resulting in the evolution of Information Technology.

The knowledge revolution, a result of aerospace and IT, gives nations like India the opportunity to leapfrog over many developmental processes and achieve considerable development economically, politically and militarily. More importantly, aerospace power will ensure that India retains its freedom of action, be it in space, air or ground.

Nature of International Orders and India's Position

The struggle is always between established or status quo powers who try to prevent any dilution or challenge to their hegemony and the revisionist or the new developing powers who want to share the power in the world in a more equitable manner.

Some of the irrefutable facts of the international system are—

The world is always dominated by major power militarily, economically, technologically and politically.

Established powers are status quo powers and will resist any attempt at changing the established world order.

The status quo powers of today are the P-5, primarily in terms of military power, and the G-7 in terms of economic power.

This order is somewhat dominated by the USA in all the fields—economic, military, technological and political.

Implications for India. A few important factors of great significance are:

India, as a nation state, is only 54 years old. Given its size and potential national power, it needs to consolidate itself as an effective and strong state.

India, by virtue of various factors—geo-strategic, geo-economic, territorial human resources, national resources, etc., is an emerging major power.

India's emergence as a peer power will be considered by established power.

India's threat analysis can be realistic only when it takes into account a global perspective, encompassing technological, economic, political and military factors.

Aerospace Power

Aerospace power can be defined as the synergistic application of air, space and information systems. This synergistic combination has an overwhelming influence on the economic and military power of a nation.

Economic Implications. Telecommunication as the largest sector of commercial aerospace activities.

Remote sensing to exploit resources and study earth's environment.

Networking of computers and communication through satellites.

Environmental data about weather.

Use of GPS (Global Positioning System) by commercial ventures.

Global internet connectivity of education and commerce.

Satellite communication for worldwide data link, data transfer and commerce. Economic investment in the aerospace sector are increasing rapidly all over the world, with about 800 active satellites orbiting the earth of which 70% are of US, Russian and former USSR origin. This number is expected to grow to between 1500 and 2000 satellites by 2010 of which nearly 60% will be from countries other than the USA and Russia.

Today over 1100 companies in 53 countries are engaged in aerospace research, development and manufacturing activities.

Today the revenues from the aerospace sector in the US alone are about $125 billion. This is expected to increase worldwide to about $600 to $800 billion. By 2015 this is likely to exceed $3 trillion.

Military Implications. In the 21st Century the core characteristics that aerospace power will bring to warfare would be:

Information
Command and Control
Precision
Penetration

The information is the central core of warfare. Aerospace technology would allow the use of chaos and complexity theories to arrive at the best decision after expert processing of data and information.

Aerospace technologies with modern sensors, airborne and space-based, will provide a real time situational awareness and comprehensive three dimensional view of the battlefield to future commanders.

Precision and penetration are outcome of aerospace technologies that exploit GPS for navigation and targeting, optical and LASER designation for precision guided munitions, cruise missiles, and weapons using fire and forget as well as self-actuating technologies.

The four characteristics of aerospace affect warfare and international relations at three levels. These are—

Level-I. Technology dominance, which leads to enhancement of various tools such as Electronic Warfare (EW), PGMs, etc. This level is one of Military Technological Revolution (MTR).

Level-II. Aerospace power will bring in conceptual changes leading to knowledge-based combat, command dominance and command and control warfare. It is the Revolution in Military Affairs (RMA).

Level-III. It is at the larger national and international levels where concepts will lead to a Revolution in Strategic Affairs (RSA). International relations and warfare will focus on perception management, functional disruption, destruction of the adversary using information warfare and the emergence of concept of strategic information warfare.

Aerospace Power and Future Warfare

Exploitation of aerospace power will transform future wars considerably. The two concepts that will have major influences on the conduct of future operations are—

(1) OODA (Observe, Orient, Decide and Act) Loop Theory.
(2) Parallel warfare.

(1) OODA loop theory was evolved by Colonel John Boyd of the US Air Force, which focuses on the time mind space paradigm wherein one could always wrest or retain the initiative and control over an adversary by remaining ahead of him in the OODA cycle.

(2) Parallel warfare is the conduct of war at the strategic, tactical and operational levels simultaneously. The synergistic combination of information, precision and smart weapons, accurate and long reach aided by technologies such as GPS and stealth, allows an aerospace nation to follow a comprehensive execution of a battle or war. The parallel war-game concept, advocated as five ring theory by Colonel Warden of the US Air Force, was put into operation effectively in the 1991 Gulf war. It is the destruction of leadership, organic essentials, infrastructure, population and field forces.

The combination of parallel warfare and OODA loop can lead to strategic paralysis of the enemy.

Appendix C
(Refer Section VII page 145)

JOINT PROPOSAL OF THE UNITED STATES OF AMERICA AND THE RUSSIAN FEDERATION TO THE STANDING CONSULTATIVE COMMITTEE PERTAINING TO AMENDING THE TREATY BETWEEN THE UNITED STATES OF AMERICA AND THE UNION OF SOVIET SOCIALIST REPUBLICS ON THE LIMITATION OF ANTI-BALLISTIC MISSILE SYSTEMS OF MAY 26, 1972

The Russian Federation and the United States of America, recognising the importance of preserving the viability of the Treaty Between the Union of Soviet Socialist Republics and the United States of America on the Limitation of Anti-Ballistic Missile Systems of May 26, 1972, as amended in 1974, hereinafter referred to as the Treaty, with the aim of maintaining strategic stability.

Recognising the necessity of preserving strategic stability.

Encouraging the multilateralization of this Treaty.

Reaffirming each Party's commitment not to circumvent the Treaty by exportation of anti-ballistic missile systems or their components to States not party to the Treaty.

Understanding that the provisions of this proposal do not apply to the weapons systems that are not strategic defence systems pursuant to the September 26, 1997 Second Agreed Statement Relating to the Treaty between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems of May 26, 1972.

Have, in connection with the Treaty, agreed to the following amendments to the Treaty with the understanding that they will be presented to the Standing Consultative Committee in the form of a joint US-Russian proposal for legal implementation and inclusion in the Treaty.

Article I

The parties agree to amend Section 2 of Article I of the Treaty to allow for the deployment of national missile defence to read as follows,

1. Each Party undertakes to limit Anti-Ballistic Missile (ABM) systems and to adopt other measures in accordance with the provisions of this Treaty.

2. Each Party undertakes not to deploy ABM systems except as provided for in Article III of this Treaty.

Article II

The parties agree to amend Article III of the Treaty in regards to increasing the deployment area, to read as follows,

1. Each Party undertakes not to deploy ABM launchers and interceptor missiles or their components except that:

(a) Within on ABM system deployment area having a radius of two hundred kilometres and centred on the Party's national capital, a Party may deploy ABM launchers and ABM interceptor missiles and launch sites; or

(b) Within on ABM system deployment area having a radius of two hundred kilometres and containing ICBM silo launchers, a Party may deploy ABM launchers and ABM interceptor missiles at launch sites.

Article III

The parties agree to amend Article III of the Treaty by adding the following language in regards to lessening radar restric-

tions and providing for ABM system site changes,

1. Each Party undertakes not to deploy ABM radars or their components except that:

(a) Parties may deploy ABM radars and their components exclusively on their sovereign national territory.

(b) There shall be no quantitative restrictions on ABM radars.

2. Each country agrees, as a point of clarification, that early warning systems are not considered ABM components even when used in a missile defence system, so long as information obtained from the early warning system (specifically guidance and targeting information) is not directly fed to the missile interceptor without first going through a human interface.

3. Each interceptor missile above 150 ABM interceptor missile will be counted against each Party's total nuclear warhead limit in the ratio of 1:1, one interceptor missile is equal to one nuclear warhead, as provided for in Article Q1.1 of the START III Treaty.

4. Each Party may choose to change the location which its ABM system and components are centered around to comply with either option one or option two of Article III of the Treaty, so long as six months prior notice to all other Parties of the Treaty is given.

Article IV

The parties agree to amend Section I. 1 of Article V of the Treaty to allow for mobile land-based ABM components and to read as follows,

1. Each Party undertakes not to develop, test, or deploy ABM systems or components which are sea-based, air-based, or space-based.

(a) A space-based component is defined for the purposes of this proposal as either a space-based interceptor missile, or any space-based device that transmits telemetry data to the

interceptor missile guidance system without a human interface.

Article V

The provisions of the telemetry protocol to the START I Treaty shall apply to all interceptor missiles in this joint proposal.

Article VI

This joint proposal shall come into force on the date of the exchange of the instruments of ratification of the START III Treaty by both parties, unless the parties agree otherwise.

DONE at Monterey, California on May 3, 1999, in two copies, each in the English and Russian languages, both texts being equally authentic.

FOR THE UNITED STATES OF AMERICA:

ALISON BARR

Ambassador for the United States of America

ENDNOTES

Chapter–I—Introduction to Space Warfare and Military Strategy

1. Many German scientists over so many years have been studying the Indian epics with a view to predict future weapons. Both *Ramayana* and *Mahabharata* have mentioned about weapon systems, which can be compared to same weapons of today and tomorrow. The concept of *Pushpaka Vimanam* is akin to Hyper planes and spacecrafts. The various *astras* as mentioned are like guided missiles of the 10th generation type, where guidance will be through the mind of commanders something like laser designation. The author has done original research on this aspect by interviewing various hermits in the Himalayas, who still quote the Indian epics, carried forward over thousands of years by word of mouth.
2. Everett C Dolman has been a military thinker and strategist, who has written many articles on space related military affairs.

Chapter–II—Fundamentals of Space

1. In *Ramayana* and *Mahabharata*, enough instances are there where Intercontinental and Inter-planet arrows have been launched akin to the concept of Intercontinental Ballistic Missile (ICBM) and Space based weapons.
2. Joseph Swain and William Armstrong, *Peoples of the Ancient World*, (New York: Harper and Row, 1959), p. 306 and Carl Sagan, *Cosmos* (New York: Random House, 1980), pp. 188–89.
3. Thomas S. Kuhn, *The Corpernican Revolution*, (Cambridge, Mass: Harvard University Press, 1957), pp. 185–199; and Willy Lay, *Rockets, Missiles and Space Travel*, (New York: Viking, 1968), pp. 10–11.
4. William J. Durch (ed.) *National Interests and the Military Use of Space*, (Massachusetts: Ballinger Publishing Company), p. 90.

5. Extracts taken out from a well researched book of Chanchal Uberoi *Earth's Proximal Space* Universities Press (India) Limited.
6. *Ibid*, book.
7. *Ibid*, p. 77.
8. *Ibid*, p. 7. Actually the word magnetosphere was coined by T. Gold in 1959 (The same was revealed by the author in an American Geophysical union in 1994). Obviously the word '*Lakshman Rekha*' has been coined from the famous Indian epic, the *Ramayana*.
9. Extracts taken from the book *Military Space* Brassey's Air Power: Aircraft, weapon systems and technology series, Volume 10, (Brassey's UK, member of the Maxwell Permagon Publishing Corporation, 1990) pp. 13–18.
10. If the angle of inclination for our easterly launch from Canaveral is measured, it would equal 28.5 degrees which happens to be the value of northerly latitude of Canaveral. By varying the direction of launch the angle of inclination can be increased from 28.5 degrees up to 90 degrees and even to 151.5 degrees (28.5–151.5) if required, but from Canaveral it is impossible to launch directly into an orbit inclined at less than 28.5 degrees. So, therefore, the minimum orbital inclination achievable is equal to the latitude of the launch site. But, of course, it is well known that the United States achieves equatorial orbits from Canaveral, so how do they do it?

    Equatorial orbits from Canaveral are achieved by launching due east into a parking orbit (inclination 28.5 degrees) and then, as the craft crosses the equator, a rocket motor is fired to affect a plane change into equatorial orbit. To achieve this manoeuvre, payload has to be sacrificed in favour of the rocket motor and the necessary amount of fuel, so this manoeuvre, though sometimes essential, costs dearly in terms of payload.

    Before leaving Canaveral, it is worth considering one more direct consequence of the angle of inclination: the effect on maximum payload of changing the launch direction. Launched eastwards with the full benefit of the earth's spin, the original Space Shuttle specification called for around 30 tonnes to be lifted into low earth orbit at around 300 km. If, however, a polar launch is used (inclination = 90 degrees) without the benefit of the earth's spin, the maximum payload reduces dramatically to only 19 tonnes. If the inclination is further increased to 98 degrees, which is a particularly useful orbit, a component of the earth's spin acts in

the opposite direction to launch and the maximum payload reduces even further to 14 tonnes. (Extracts from Brassey's Military Space' book.)

Chapter–III—Satellites in Space: Utilisation

1. United Nations, *Disarmament: Problems related to Outer Space*, United Nations Institute for Disarmament Research, Geneva, 1987, p. 10.
2. *Soviet Space Studies*, (Moscow: Novosti Press Agency Publishing House, 1983), p. 2.
3. Bhupendra Jassani, (ed.), *Space Weapons – the Arms Control Dilemma*, (Sweden: Stockholm International Peace Research Institute, 1984), pp. 11–12.
4. *Ibid*, p. 16, (*DOD's Space Based Laser Programme – Potential Progress and Problems.* General Accounting Office, Report No C-MASAD-82-10, February 26, 1982).
5. *Ibid*, p. 17.
6. John Pike "Anti Satellite Weapons and Arms Control" *Arms Control Today*, December 1983, pp. 5–7.
7. Bhupendra Jassani: Emerging Technologies; *Disarmament, a period review by the United Nations*, Vol X No. 2, Summer 1987, p. 26.
8. Graham, D.O., *High Frontier—A New National Strategy*, (High Frontier–Washington DC, 1982), pp. 119–128.
9. Bhupendra Jassani, "The Military Use of Outer Space", *World Armaments and Disarmament, SIPRI Yearbook 1986*, (Oxford: Oxford University Press), pp. 131–157.
10. Craig Covault, "Disarmament: Problems Related to Outer Space" *United Nations Institute for Disarmament Research Journal*, 1985, p. 24. "USAF initiates broad programme to improve surveillance of Soviets", *Aviation Week and Space Technology,* 21 January 1986, pp. 14–17.
11. *Ibid*, p. 25.
12. *Ibid*, p. 27.

Chapter–IV—Metamorphosis to Space Warfare

1. Roman Kolkowicz, *Dilemmas of Nuclear Strategy*, edited and published by Frank Casualties and Company Limited, p. 5.
2. During the seminar on 'Ballistic Missile Defences' in India International Centre, New Delhi in July 2001, in which the convener was the Institute of Defence Studies and Analysis (IDSA) and

the key speaker was Mr K Subrahmanyam, noted defence analyst, and the moderator was Dr K Santhanam, Director IDSA.

3. Dr V Siddhartha is scientific Advisor in DRDO. He also gave a lecture in the United Service Institution, India, New Delhi. Further, the author has had many private deliberations with him.
4. H J Mackinder, 'The Geographical Pivot of History', Geographical Journal 23/24 (April 1904) pp. 421–44 and iden. *Democratic Ideals and Reality: A Study in Politics of Reconstruction and impact on military strategies*. (Ny; Henry Holt 1919).
5. Joseph Swain and William Armstrong, *Peoples of the Ancient World*, (New York: Harper and Row, 1959), p. 306 and Carl Sagan, *Cosmos*, New York: Random House, 1980, pp. 188–189.
6. Thomas S Kuhn, *The Copernican Revolution* (Cambridge, Mass: Harvard University Press, 1957), pp. 185–199; and Willy Lay, *Rockets, Missiles and Space Travel* (New York; Viking, 1968), pp. 10–11.
7. William J Durch "National Interests and the Military Use of Space" edited Ballinger Publishing Company, Cambridge, Massachusetts, a subsidiary of Harper and Row Publishing Inc.
8. Many German scientists over so many years have been studying the Indian epics with a view to predict future weapons. Both *Ramayana* and *Mahabharata* have mentioned about weapon systems, which can be compared to some weapons of today and tomorrow. The concept of *Pushpaka Vimanam* is akin to Hyper planes and spacecrafts. The various *astras* as mentioned are like guided missiles of the 10th generation type, where guidance will be through the mind of commanders something like laser designation. The author has done original research on this aspect by interviewing various hermits in the Himalayas, who still quote the Indian epics, carried forward over thousands of years by word of mouth.
9. In *Ramayana* and *Mahabharata*, enough instances are there where Intercontinental and Inter-planet arrows have been launched akin to the concept of Intercontinental Ballistic Missile (ICBM) and Space based weapons.
10. In this connection lot of reference and thought has been taken from various literature pertaining to this type of warfare as researched by Rand Corporation of India. Further, the author has also applied his own assessment of tomorrow's warfare.

Chapter–V—Concept of Operations and Army's Role

1. Moorman, *Space: A New Strategic Frontier*, p. 22.

Chapter–VI—Evolution of Space Militarisation

1. The Gulf War can be actually called the first space war.
2. This highlights India's case for also getting into strategic alliance with Russia or USA.
3. It can be called the Strategic High Ground in times to come.

Chapter–IX—Space Capabilities: An Asian Perspective

1. Primacy of deception is yet another key factor in Chinese traditional strategy.
2. Zhang, Shu Guang, *Deterrence and Strategic Culture*, (New York: Cornell University Press, 1992), p. 273.
3. Godwin, Paul, and Schulz, Johan J, "Arming the Dragon for the 21st century: China's Defence Modernization Programme" *Arms Control Today*, (December 1993).
4. *Ibid*, p. 7.
5. *Ibid*, p. 7.
6. Nair, VK, "Defince forces and Nuclear Weapons and China's Foreign Policy", *China Report* 28.3 (1992), p. 222.
7. Godwin, Paul, and Schulz, Johan J "Arming the Dragon for the 21st century. China's Defence Modernization Programme" *Arms Control Today*, (December 1993). p. 6.
8. Ray Chengappa , "Moon Mission", *India Today*, July 3, 2000.
9. Nuchad Pillsburg, *Chinese Views of Future Warfare*, (Lancer Publisher, 1997), p XXXVII.
10. Dr V Siddhartha, "Military Dimension in the Future of the Indian Presence in Space", *USI Journal* (April–June 2000), p. 243.

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